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November 13, 2008

**FILED ELECTRONICALLY**

Ms. Sandra J. Paske
Secretary to the Commission
Public Service Commission of Wisconsin
610 North Whitney Way
P.O. Box 7854
Madison, Wisconsin 53707-7854

**RE: Joint Application of Wisconsin Power and Light Company and Wisconsin Electric Power Company for Certificate of Authority for Edgewater Generating Station Unit 5 NOx Reduction Project** — **Docket No. 5-CE-137**

Dear Secretary Paske:

Wisconsin Power and Light Company ("WPL") and Wisconsin Electric Power Company ("WEPCO") respectfully and jointly submit the attached Application for Certificate of Authority for Edgewater Generating Station Unit 5 NOx Reduction Project for the Commission's consideration. Furthermore, we respectfully request that the Commission, upon completion of its review, approve the proposed project and issue a Certificate of Authority.

The service list for this docket should contain the following information:

WISCONSIN POWER AND LIGHT COMPANY
Scott R. Smith
PO Box 77007
Madison, WI 53707-1007
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ALLIANT ENERGY
Wisconsin Power and Light

# Certificate of Authority Application
# Edgewater Generating Station Unit 5
# NOx Reduction Project

## Project Description and Justification

## Wisconsin Power and Light Company
## Madison, Wisconsin

November 2008

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**FIGURES AND TABLES**

## ACRONYMS AND ABBREVIATIONS

acfm – actual cubic feet per minute
B&W – Babcock & Wilcox
BART – Best Available Retrofit Technology
CA – Certificate of Authority
CAA – Clean Air Act
CACP – Clean Air Compliance Group (part of WPL)
CAIR – Clean Air Interstate Rule
CAMR – Clean Air Mercury Rule
CAVR – Clean Air Visibility Rule
CO – Carbon Monoxide
$CO_2$ – Carbon Dioxide
DCS – Distributed Control System
EGEAS – Electric Generation Expansion Analysis System
EPA – Environmental Protection Agency
EPRI – Electric Power Research Institute
ESP – Electrostatic Precipitator
FIP – Federal Implementation Plan
GHG – Greenhouse Gas
$H_2O$ – water
ID – Induced Draft
IRP – Integrated Resource Plan
LNB – Low NOx Burners
MM – Million
MMBtu – Million British Thermal Units
MW – Megawatts
$N_2$ – Nitrogen
NAAQS – National Ambient Air Quality Standards
$NH_3$ – Ammonia
NOx – Nitrogen Oxides
NPVRR – Net Present Value Revenue Requirement
PM – Particulate Matter
$PM_{2.5}$ – Particulate Matter less than 2.5 microns (μm) in diameter
PPA – Purchase Power Agreements
PSCW – Public Service Commission of Wisconsin
PSD – Prevention of Significant Deterioration
PRB – Powder River Basin
RACT – Reasonably Available Control Technology
RRI – Rich Reagent Injection
SAM – Sulfuric Acid Mist
scfm – standard cubic feet per minute
SCR – Selective Catalytic Reduction
SIP – State Implementation Plan
SNCR – Selective Non-Catalytic Reduction
RPS – Renewable Portfolio Standard
SOFA – Separated Overfire Air
$SO_2$ – Sulfur Dioxide
$SO_3$ – Sulfur Trioxide
SPC – Strategic Planning Committee
WDC – Wisconsin Department of Commerce
WDNR – Wisconsin Department of Natural Resources
WDT – Wisconsin Department of Transportation
WEPCO – Wisconsin Electric Power Company
w.g. – water gauge
WPL – Wisconsin Power and Light Company

**BEFORE THE**
**PUBLIC SERVICE COMMISSION OF WISCONSIN**

| | | |
|---|---|---|
| Application of Wisconsin Power and Light Company and Wisconsin Electric Power Company for a Certificate of Authority to Install a NOx Reduction System, Selective Catalytic Reduction (SCR) at the Edgewater Generating Station on Unit 5 | ) ) ) ) ) ) | Docket No. 5-CE-137 |

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## APPLICATION

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Wisconsin Power and Light Company (WPL) and Wisconsin Electric Power Company (WEPCO), cumulatively referred to as "applicants", make this application, pursuant to section 196.49 of the Wisconsin Statutes, Chapter PSC 112 of the Wisconsin Administrative Code and any other applicable statute or rule for a Certificate of Authority (CA) to install a Selective Catalytic Reduction (SCR) system for NOx removal on Unit 5 at the Edgewater Generating Station in Sheboygan County, Wisconsin.

WPL is a public utility organized and existing under the laws of the State of Wisconsin with its principal offices located at 4902 North Biltmore Lane, Madison, Wisconsin 53707. WEPCO is a public utility organized and existing under the laws of the State of Wisconsin, with its principal offices located at 231 West Michigan St, Milwaukee, WI 53203.

Dated this 13th day of November, 2008.

Respectfully submitted,

WISCONSIN POWER AND LIGHT COMPANY

By: ______________________________

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And

WISCONSIN ELECTRIC POWER COMPANY

By: ______________________________

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## Introduction

In this Certificate of Authority application, Wisconsin Power and Light Company (WPL) and Wisconsin Electric Power Company (WEPCO) are requesting authorization to install a Selective Catalytic Reduction (SCR) system for control of Nitrogen Oxides (NOx) on Unit 5 at the Edgewater Generating Station in Sheboygan County, Wisconsin. WPL owns 75% of Edgewater Unit 5, and WEPCO holds 25% ownership. The unit consists of a wall-fired boiler currently operated at 430 MW gross generation and a cold-side Electrostatic Precipitator (ESP) for particulate emissions control. Because Sheboygan County has been designated an ozone non-attainment area, the Edgewater Generating Station must contribute to improving air quality in the area by complying with Reasonably Available Control Technology (RACT) requirements as set forth in the Wisconsin Administrative Code, Chapter NR 428. Specifically, RACT requirements under NR 428 necessitate that emission sources reduce their NOx emissions to comply with Phase I and Phase II emissions reduction requirements beginning in 2009 and 2013 respectively.

WPL has developed a plan for reducing NOx emissions from the Edgewater Generating Station to comply with RACT requirements as set forth in NR 428. WPL has optimized combustion and upgraded burner technology on existing Edgewater units, including the completed installation of SmartBurn technology on Edgewater Unit 5. WPL is in the process of installing SNCR/RRI technology on Edgewater Units 3 and 4, with in-service dates planned for December 2008. WPL views the installation of this SCR system on Edgewater Unit 5 as another key component in the NOx reduction plan.

Phase I RACT compliance is expected to be met through a facility-wide NOx emissions averaging plan for the Edgewater Generating Station. The SCR on Edgewater Unit 5 is scheduled for commercial operation in the Spring of 2011 to ensure that the unit is compliant with RACT Phase II. WPL determined, through an independent engineering assessment, that this SCR project is the only feasible option for Edgewater Unit 5 to comply with Phase II RACT requirements.

This SCR project is estimated to cost $153 MM and, based on WPL's ownership share of the project, has a Net Present Value Revenue Requirement (NPVRR) benefit in excess of [redacted] when compared to retiring the unit, based on WPL's EGEAS analysis. WPL's EGEAS project payback period has been calculated to be approximately six years.

WEPCO plans to separately file a cost and need analysis for this project which will include their modeling results. The results demonstrate that the continued operation of Edgewater Unit 5 with the proposed NOx controls is the least cost option for their customers.

## 1.0 Project Description

The Edgewater Generating Station is located south of Sheboygan, Wisconsin, along Lake Michigan (Figure 1). Edgewater Unit 5 began operating in 1985 with a design gross capacity of 380 MW. The unit currently runs at gross maximum operating load of 430 MW and burns low sulfur Powder River Basin (PRB) coal. Edgewater Unit 5 has a Babcock & Wilcox (B&W) wall-fired boiler retrofitted with Separated Overfire Air (SOFA) technology and Low NOx Burners (LNB) (SmartBurn technology) to reduce NOx emissions, followed by a cold-side ESP for particulate emissions control. The proposed project addressed in this CA application is an SCR installation on Edgewater Unit 5 for NOx emissions reduction necessary to meet RACT requirements at the Edgewater Generating Station.

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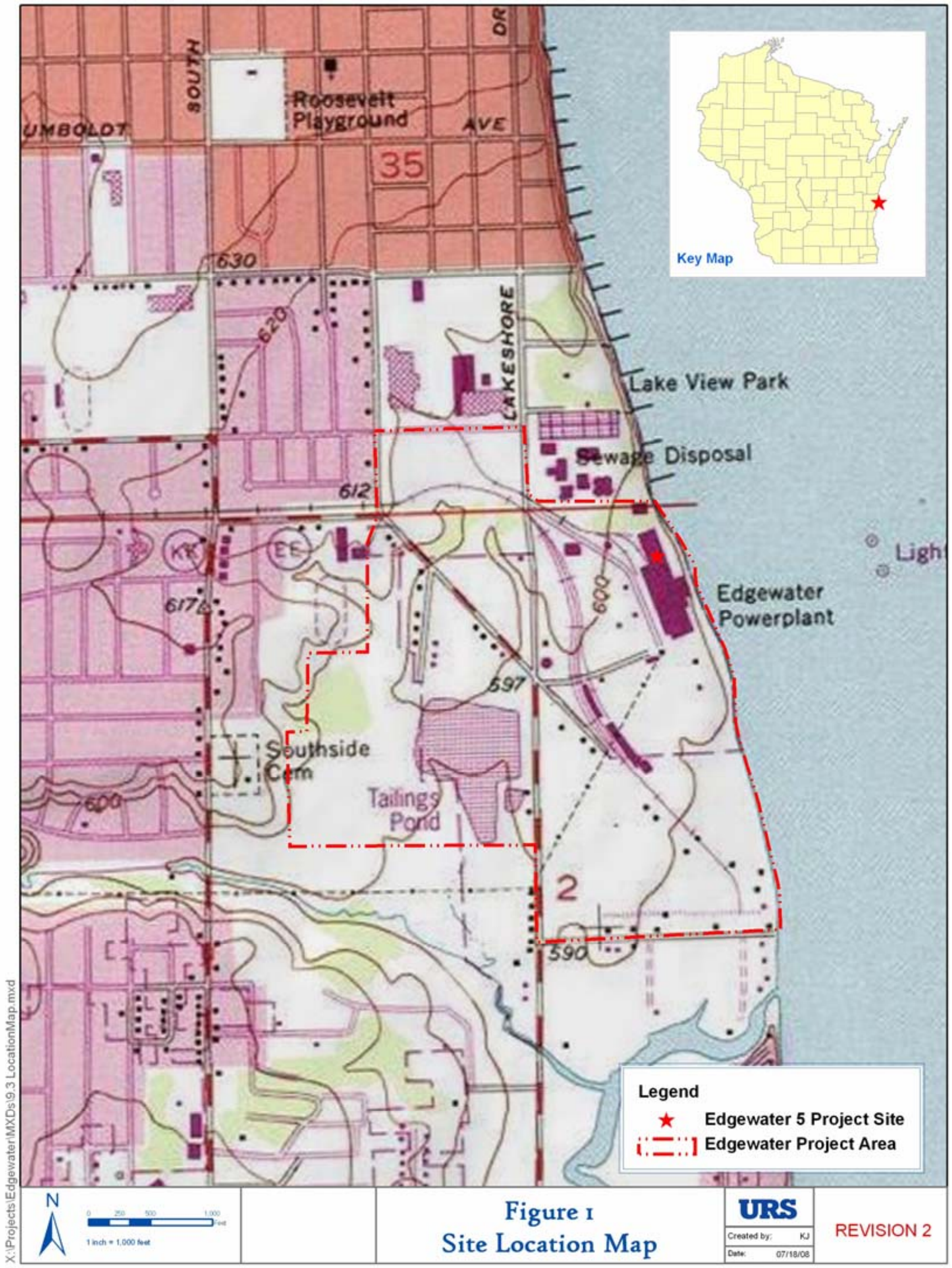


*Figure 1. Edgewater Unit 5 SCR Project Location Map*

The proposed project includes installation of Selective Catalytic Reduction (SCR) technology for NOx reduction on Edgewater Unit 5, which would also include installation of 19% aqueous ammonia reagent tanks, an ammonia feed building, associated tie-in ductwork, and support structures. The following sections describe the selected technology as it applies to Edgewater Unit 5, the proposed site layout, and construction approach. This information is based on preliminary system design and subject to revision with further detailed design and selection of equipment vendors. The schedule for the project is to begin detailed engineering in the first quarter of 2009 with commercial operation expected by Spring of 2011.

Figure 2 shows the typical integration of an SCR system into a utility boiler application. The Edgewater Unit 5 SCR installation will be similar to this layout, with the SCR located in front of the ESP and mounted over the fan room, in series with existing operations. Note that this figure shows an SCR reactor bypass, which will not be included in the Edgewater Unit 5 SCR system.

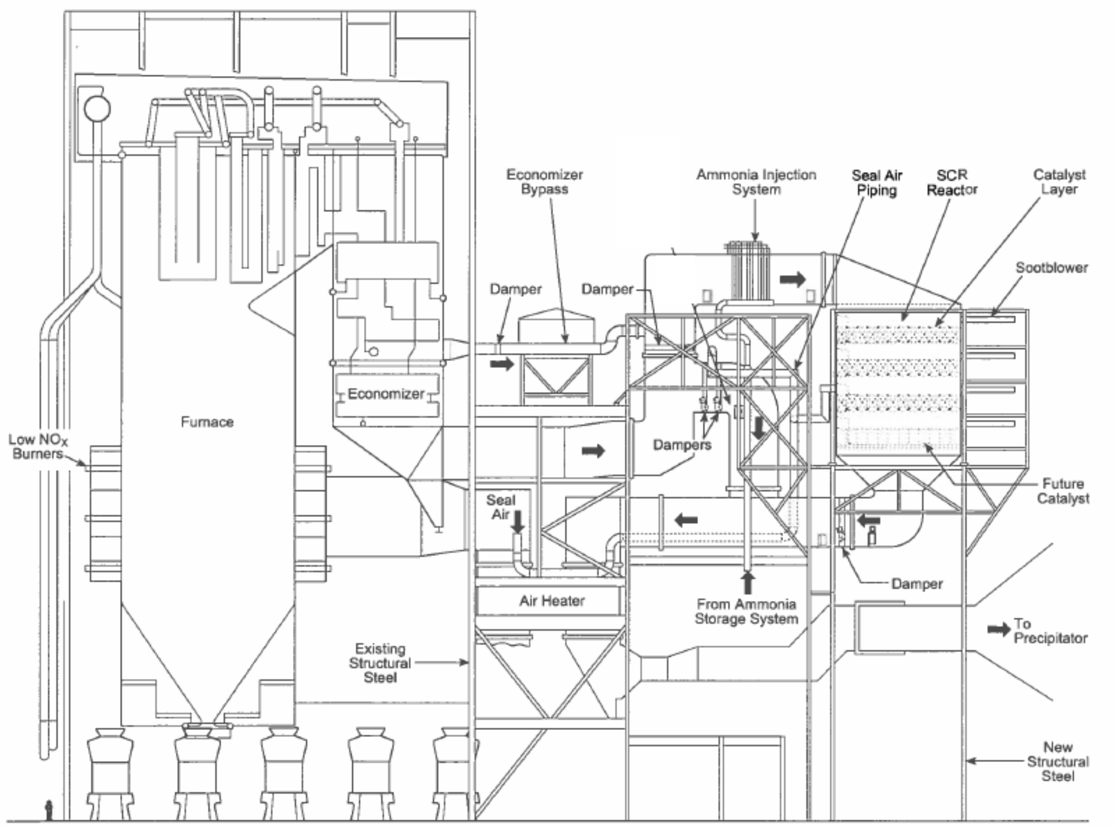


*Figure 2. Typical SCR Reactor Design*[1]

The site arrangement in Figure 3 (enlarged in Appendix A) shows a plot plan of the Edgewater Unit 5 SCR project relative to existing units. The Edgewater Unit 5 SCR will be located in front of the existing precipitator and will be mounted directly over the fan room at the north side of the Edgewater Unit 5 boiler building. Ammonia storage tanks, transfer pumps, and control building will be located west of the turbine building as indicated in Figure 3. Major transportation modes, rail and road access exist up to the construction area. Temporary roads to the construction site will be required during

[1] Stultz, S.C., J.B. Kitto, and G.L. Tomei, eds. Steam: Its Generation and Use. Boston: Babcock & Wilcox Company, 2005.

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construction. Note that the information displayed in Figure 3 is conceptual, based on preliminary design, and may be modified during detailed engineering.

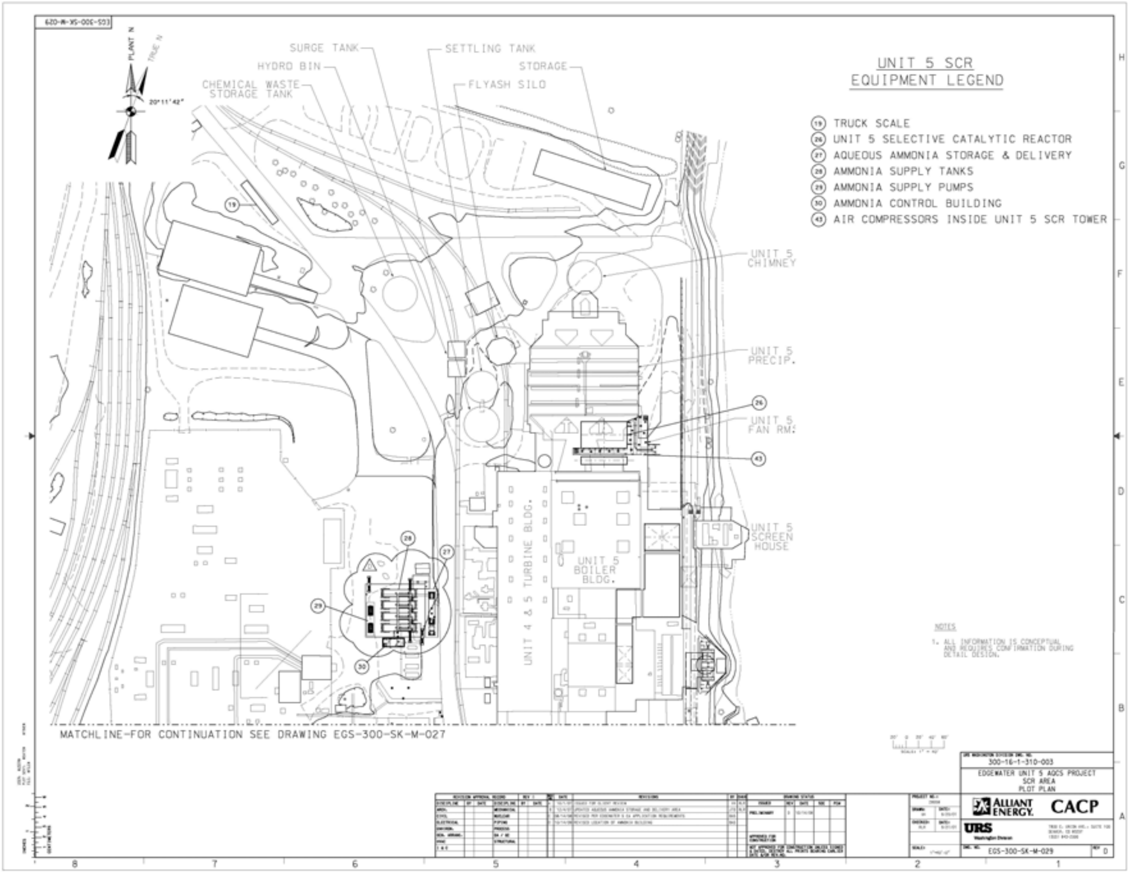


*Figure 3. Site Layout – Proposed Edgewater Unit 5 SCR System*

## 1.1 Technology Objectives

The SCR NOx control system for Edgewater Unit 5 will be designed to meet the following objectives:

- Reduce NOx emissions to meet Phase II RACT requirements and improve air quality in Wisconsin
- Reduce NOx emissions to required levels with the most cost effective technology
- Minimize adverse impacts to other regulated pollutants
- Maintain existing fuel flexibility
- Maintain the reliability, operability, and performance of the units and new equipment
- Minimize disruption to operations during the construction period
- Minimize outage time during construction tie-ins.

## 1.2 Selected Technology

The technology proposed for NOx reduction at Edgewater Unit 5 is a selective catalytic reduction (SCR) system. In an SCR system, NOx, is removed via reaction with an ammonia-based reagent ($NH_3$), resulting in molecular nitrogen ($N_2$) and water vapor ($H_2O$). The major reactions are the following:

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$
$$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$$

The NOx reduction reactions occur as the flue gas passes through the catalyst chamber. The Edgewater Unit 5 SCR is designed to use 19% aqueous ammonia solution as the reducing agent. Anhydrous ammonia was also considered, but discounted due to associated safety concerns with storing and handling a toxic compressed gas. The aqueous ammonia reagent is vaporized and injected into the flue gas downstream of the economizer through an injection grid mounted in the ductwork. Compressed air is used to atomize the aqueous ammonia reagent. The hot flue gas and atomized reagent then flow into the catalyst chamber where NOx is reduced to nitrogen and water. The nitrogen gas and water vapor leave the SCR system and flow out the stack with the flue gas.

The preliminary design of the SCR at Edgewater Unit 5 consists of the following components: one reactor with not fewer than three layers of catalyst, an ammonia storage and delivery system, an ammonia injection system, an in-duct mixing apparatus, steam soot blowers, sonic horns, instrumentation, inlet ductwork from economizer to SCR including expansion joints, outlet ductwork from SCR to air heaters including expansion joints, an economizer bypass, SCR inlet and outlet NOx monitors, as well as an $NH_3$ monitor at the SCR outlet.

Based on Edgewater Unit 5 current operation, the SCR system will be designed to meet 75% removal efficiency, or 0.06 lb/MMBtu average outlet NOx over the life of the catalyst, and will allow no more than 5 ppm $NH_3$ slip. There are a number of vendors that manufacture SCR reactors based on specific catalyst designs. WPL solicited proposals for engineering and procurement during the third quarter of 2008 and expects to request proposals from constructors in the fourth quarter of 2008. No preference will be given to any particular vendor.

## 1.3 Construction Approach

The following is a high-level overview of the construction approach for the project. Two primary objectives in the design, construction, and start-up of this equipment are to minimize impact on the operation of the unit during construction and to minimize the tie-in outage time.

<u>Civil</u>
Structures, components and foundations will be designed so that their strength equals or exceeds the effects of factored load combinations. Deep foundations will be used for

heavy loaded SCR support columns; all other foundations, such as for the ammonia storage area, will be shallow foundations. These will be installed early in the construction phase of the project.

<u>Selective Catalytic Reduction (SCR) System</u>
The SCR reactor will be mounted over the fan room at the north side of Edgewater Unit 5 boiler building. This location minimizes the length of inlet/outlet duct necessary to direct flue gas from the economizer outlet to the SCR and return the treated flue gas from the SCR to the existing air heaters. Currently, no reactor bypass is included, and the plant expects to run the SCR year round. Catalyst cleaning will be accomplished by sonic horns with provisions for future steam soot blowers.

<u>Ammonia Handling/Injection System</u>
Ammonia storage for the Edgewater Unit 5 SCR will be located on the west side of the Unit 5 turbine building in a diked area. Ammonia storage will be based on aqueous ammonia (19% by weight) delivered to the site by truck and likely stored in bullet type tanks. The injection system will consist of pre-wired ammonia supply skids, including necessary pumps, gauges, isolation valves, electrical panel, and input/output junctions for connection to the plant distributed control system (DCS). An ammonia injection system will be provided with the SCR. The ammonia injection system is comprised of an ammonia flow control system and an atomization air system.

<u>Ductwork</u>
Ductwork will be added from the economizer to the SCR inlet and from the SCR outlet to the air heater inlet. Sufficient duct length before the reactor will be provided to ensure that ammonia will uniformly mix with the flue gas. Additionally, an economizer bypass will be included to maintain required operating temperatures to the SCR and avoid ammonium bisulfate plugging problems at low load operation. Quality non-metallic ductwork expansion joints will be used.

<u>Mechanical Equipment</u>
Existing Induced Draft fans (ID fans) with no modification would operate at higher capacity after addition of SCR (operating at 95% from previous 80% capacity). It is anticipated that in order to maintain reasonable operating margin on the fans, either fan modifications or upgrades will be necessary. Additional engineering studies will determine the final decision on the need for ID fan modifications.

<u>Electrical</u>
Electrical equipment will be installed on elevated concrete pads to prevent water intrusion. The AC auxiliary distribution system will be supplied from the existing plant power, requiring a new transformer and motor control center in the SCR area. The existing electrical system is expected to provide DC and vital AC requirements for the SCR system. Cables will be installed in cable trays, conduit and underground ducts. Additional ground protection, lighting systems, heat trace system, voice communication systems, and fire detection systems will be installed as necessary for safe and efficient operation of the SCR.

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Instrumentation and Controls

New instrumentation and controls are required for the SCR and ammonia tank farm systems. The additional instrumentation and controls will be integrated into the plant's existing distributed control system (DCS). The primary control functions will be automated process control, system monitoring, and operational alarms. New controllers and operator workstations will be integrated into existing operator interfaces.

### 1.4 Constructability Summary

Based on site reviews and other assessments by engineering consultants, an SCR system is feasible for Edgewater Unit 5. As mentioned previously, the SCR will be located in front of the existing electrostatic precipitator mounted directly over the fan room. Laydown space is available west of Lakeshore Drive. Road and rail access exists up to the construction area, and additional temporary roads will be required for construction. Activities requiring more investigation prior to finalizing the construction approach include the following:

- Layout of selected vendor's specific equipment
- Evaluation of necessity of ID fan upgrades
- Confirm foundation design with geotechnical report
- Structural analysis of ductwork upstream of air heater and ESP to determine if additional pressure on these sections will require strengthening
- Review of fire protection system requirements by local fire officials.

It is expected that these issues will be finalized after the vendor is selected and detailed engineering is complete.

### 1.5 Milestone Schedule

The following is a preliminary milestone schedule for the Edgewater Unit 5 SCR project. This schedule will be refined after the engineering, procurement, and construction contracts have been signed and detailed engineering begins. Equipment lead times have been getting longer as equipment demand increases. Equipment lead time will be a considerable factor in meeting the project completion schedule.

| Milestone | Date |
|---|---|
| Issue Request For Proposal (RFP) for engineering and procurement | Aug 2008 |
| Issue RFP for constructor | Oct 2008 |
| Submit CA application to PSCW | Nov 2008 |
| Award engineering and procurement contract (limited notice to proceed) | Mar 2009 |
| Award constructor contract (limited notice to proceed) | May 2009 |
| Receive CA (expected) | Nov 2009 |
| Begin Construction | Post CA Approval |
| Edgewater Unit 5 SCR project completion | Spring 2011 |

## 2.0 Cost and Financing Estimates

An independent engineering consultant developed capital and operating and maintenance cost estimates for the Edgewater Unit 5 SCR project. The total project estimate presented in this section includes the following major items:

- Civil, Structural and Architectural items (including foundations, support and structural steel, and flue gas ductwork)
- Mechanical and process related items (SCR systems, ammonia storage and transfer systems, process piping, fire protection, and balance of plant mechanical systems)
- Electrical systems (including auxiliary power distribution, lighting, grounding, heat tracing, and the construction power system)
- Instrumentation and Controls (including DCS integration into existing system and local instrumentation and controls)
- Engineering fees, construction management, and start-up services (including commissioning and performance testing).
- Owner's costs including WPL project personnel, training, licensing and permitting support, and initial reagent inventory

Costs presented in this CA application represent the engineering consultant's estimate, prepared in January 2008, with WPL's project specific owner's costs, cost of spare equipment, contingency, and insurance expenditures. The costs have an expected accuracy of -5/+15%. As detailed design and engineering work progresses, project cost estimates will be refined.

### 2.1 Estimated Capital Cost and Cash Flow

Estimated capital costs for the Edgewater Unit 5 SCR are provided in Table 1 based upon the schedule presented in Section 1.5. These costs do not include Allowance for Funds Used During Construction (AFUDC).[2]

*Table 1. Edgewater Unit 5 SCR Estimated Capital Cost*

| Description | Cost ($) |
|---|---|
| SCR Reactor Housing and Installation | $21,209,000 |
| Ammonia Handling and Injection | $873,000 |
| Miscellaneous Equipment/ Spares/ Balance of Plant | $15,184,000 |
| Ductwork Modifications | $6,110,000 |
| General Facilities | $4,585,000 |
| Indirects | $8,449,000 |
| Craft Labor/Installation | $20,695,000 |
| Engineering / Construction Management / Start-Up Services | $14,756,000 |
| Sub-Total | $91,861,000 |
| Contingency | $20,104,000 |
| Escalation | $14,695,000 |
| Sub-Total | $34,799,000 |
| Prime Contractor's Markup | $10,898,000 |
| Owner's Costs | $16,386,000 |
| **Total Project Cost** | **$153,944,000** |

Cash flow estimates for the project are shown in Table 2. These costs include escalation and contingency, and as stated above, do not include AFUDC.

*Table 2. Edgewater Unit 5 SCR Project Annual Cash Flow*

| Year | Annual % of Total Cost | Annual Cash Flow ($)[a] |
|---|---|---|
| 2008 | 1.2% | $1,866,000 |
| 2009 | 16.4% | $25,225,000 |
| 2010 | 63.2% | $97,326,000 |
| 2011 | 19.2% | $29,527,000 |
| **Total Project Cost** | **100.0%** | **$153,944,000** |

a. Costs are presented in year-of-occurrence dollars.

[2] AFUDC is the process of including as a part of the total project the applicable carrying costs on Construction Work In Progress (CWIP) expenditures. If such CWIP balances are included in net investment rate base in a rate proceeding, then AFUDC would not be included or computed on such amounts. WPL will request 50% CWIP to be included in rate base for this project at the next available base rate case for consideration by this Commission. Because of the uncertainty of the timing and amount of AFUDC that may be applicable to this project, WPL has not included AFUDC in this estimate.

Table 3 shows the cost of this project on the basis of dollars per ton of NOx emissions removed and includes the key assumptions associated with this calculation. Capital costs for this project ($153,944,000) have been calculated to be $15,400/ton NOx removed, based on NOx emissions reduction down to 0.06 lb/MMBtu, which is the expected annual average outlet NOx emissions rate over the life of the catalyst. Inlet NOx is assumed to be the current NOx emissions from Edgewater Unit 5 with SmartBurn technology (0.16 lb/MMBtu). The calculation assumes energy produced from this unit remains essentially unchanged in the future.

*Table 3. Edgewater Unit 5 SCR Levelized Cost*

| Cost Basis Assumption | Parameter Value | Parameter Units |
|---|---|---|
| Inlet NOx emissions | 0.16 | lb/MMBtu |
| Outlet NOx emissions | 0.06 | lb/MMBtu |
| Annual NOx removed | 1,421 | Tons/year |
| Capital Cost | $153,944 | 1000 $ |
| Annual O&M Cost (2007 $) | $1,736 | 1000 $/year |
| Levelized Capital Cost | $19,400 | 1000 $/year |
| Levelized O&M Cost | $2,500 | 1000 $/year |
| Total Levelized Cost | $21,900 | 1000 $ |
| **Total Levelized Cost** | **$15,400** | **$/ton** |

All costs presented in this section are contingent upon adherence to the schedule presented in Section 1.5. Timely approval of the project will protect against increased costs arising from current equipment and materials shortages that are the result of the numerous emission reduction and new generation projects proposed and under construction. It will also allow WPL to better manage risks associated with competing for a limited supply of skilled labor (design engineers, craft labor, etc.) for these same projects.

## 2.2 Financing Mechanism

The project to install an SCR system on Edgewater Unit 5 is proposed as a traditional utility capital project. AFUDC, as applicable, will be included as part of the construction costs. Upon completion, all of the capital cost including AFUDC will be placed in-service and transferred to electric utility plant subject to traditional ratemaking treatment for recovery of such costs.

# 3.0 Need and Alternative Analysis

## 3.1 Background

This section provides an overview of the planning analysis used in developing the need for the Edgewater Unit 5 SCR system in light of current and future environmental regulations, technical feasibility, and strategic long-term financial planning. Emissions control projects are planned through WPL's overall long-term strategic planning process using a multi-emissions and fleet-wide approach in conjunction with an awareness of anticipated future regulations and evolving electricity demands. WPL's strategy focuses on long-term solutions with an emphasis on high value-added emissions control projects that capitalize on fleet-wide synergies and opportunities. The multi-emissions strategy is dynamic and considers both increasingly stringent environmental regulations and growing electricity demand on the generating units.

The decision to install SCR at Edgewater Unit 5 resulted from the promulgation of increasingly stringent air quality regulations. In 2004, the EPA designated ten counties in Southeastern Wisconsin, including Sheboygan County where the Edgewater Generating Station resides, as non-attainment areas for the ozone National Ambient Air Quality Standard (NAAQS). As a result, the Wisconsin Department of Natural Resources (WDNR) promulgated NR 428, creating new NOx emissions standards through the adoption of RACT requirements for ozone non-attainment areas in Wisconsin. RACT specifies that sources comply in two phases, Phase I limits enforced beginning in 2009 and the more stringent Phase II limits enforced beginning in 2013.

In anticipation of lower NOx emissions requirements, WPL began reducing NOx emissions at the Edgewater Generating Station in 1999 through the implementation of the Combustion Initiative. NOx emissions have already been reduced at Edgewater Units 3, 4, and 5 by 58%, 84%, and 31%, respectively, using combustion controls. The SNCR/RRI projects currently under construction on Edgewater Units 3 and 4 are expected to reduce NOx emissions on each unit by approximately 30 – 40%, and this Edgewater Unit 5 SCR is planned to reduce NOx by approximately 60 – 70% in order to meet Phase II RACT requirements, which go into effect in 2013.

WPL has deemed the installation of SCR at Edgewater Unit 5 necessary to both its operational strategy and long-term emissions compliance program. The following sections will explain WPL's compliance planning process, and the need and rationale for installation of the SCR system on Edgewater Unit 5 as part of the broader multi-pollutant compliance plan for WPL.

## 3.2 Emissions Compliance Planning Process

### 3.2.1 Compliance Strategy

WPL manages air emissions in the context of its overall strategic planning process in order to implement a multi-emissions strategy that considers both increasingly stringent environmental requirements and growing demand on its electric generating units. This planning process is highly dynamic and continually evolving. Work associated with the planning process takes place over a continuum that encompasses strategy development, long-term strategic planning, and shorter-term tactical planning. Tactical planning focuses on near-term implementation of the long-term strategic plan. Major components of WPL's planning process are discussed in this section. The basic components include:

- Update the Integrated Resource Plan (IRP)[3]
- Evaluate engineering aspects of emissions controls technical and cost data including plant operational constraints
- Develop scenarios of future air emissions reduction requirements by identifying known and proposed or pending new regulations
- Select an air emissions plan on the basis of regulatory compliance, net present value of total cost, feasibility of implementation, and technology performance
- Implement near-term tactical responses for air emissions plan as components of the longer-term strategy
- Review and update air emissions plan as part of strategic planning process.

These components of WPL's planning process are further described in Sections 3.2.2 – 3.2.7 that follow.

### 3.2.2 Update Integrated Resource Plan (IRP)

WPL's emissions planning process includes projections of electricity demand on its electric generating units based on the IRP. The IRP shows how WPL intends to continue to balance the anticipated system energy needs with energy supply. WPL estimates the system energy needs using a year-by-year forecast that includes customer demand, the energy required at the time of maximum consumption, and the total amount of energy consumed. The forecast of energy needs includes energy use by residential, commercial, and industrial customers. The forecast for WPL's system incorporates new customers based upon historical trends, and analyzing changes associated with using energy more efficiently. Through the IRP, WPL determines the most feasible and economic approach to satisfy varying electricity demand and regulatory requirements.

[3] Although WPL's 2006 IRP has not been completely updated, the EGEAS model used in the instant application reflects the May 2007 revisions to the 2006 IRP as included in PSCW Docket No. 6680-CA-170. Further updates to that version of the model include projected load, capital costs for Nelson Dewey Unit 3 and competing alternatives considered in PSCW Docket No. 6680-CA-170, emission rates, and variables germane to the instant application.

The forecast of energy needs developed through the IRP is matched against existing energy supply. If energy supply is not sufficient or economically optimal to meet energy needs, additional energy capacity is warranted. WPL uses a computer model to match existing and all feasible combinations of future energy supply alternatives together with the forecast of energy needs to assist in selecting any needed additional energy supply. Specifically, the Electric Generation Expansion Analysis System (EGEAS) computer model is used to accomplish these tasks. EGEAS is a modular production costing and energy supply expansion software package initially developed under the sponsorship of the Electric Power Research Institute (EPRI).

The EGEAS model focuses on choosing economically optimal energy supply for various scenarios, which may manifest themselves during the planning period, typically twenty or more years into the future. Various combinations of attributes that are uncertain during the planning period comprise the various scenarios. These attributes include energy needs, fuel prices, energy supply capital costs, purchase power costs, and the value of emissions reductions. EGEAS uses mathematical calculations to test feasible combinations of future energy supply alternatives and determine economically optimal combinations for each scenario analyzed. Each energy supply alternative is modeled using expected energy production characteristics, as well as operating and capital costs. EGEAS simulates matching the energy supply to the energy needs on a monthly basis.

The EGEAS model defines a combination of energy supply alternatives to be economically optimal if it minimizes the cumulative present worth of the revenue requirements during the planning and extension period and maintains a defined level of energy supply reliability.

The results of the EGEAS modeling are one facet of the IRP process. The process must also consider financial, operational and regulatory risks which the EGEAS model cannot explicitly incorporate. WPL considers these risks in its broader IRP process that extends beyond the use of the EGEAS model. After carefully considering the scenarios analyzed using the EGEAS model and their associated financial, operational and regulatory risks, WPL constructs an IRP reference base case. WPL uses the projected future generating unit output from the IRP reference base case for projecting future air emissions.

Section 3.4 describes EGEAS runs specific to this project.

### 3.2.3 Evaluate Engineering Aspects of Emissions Controls

WPL's Clean Air Compliance Program (CACP) engineering team evaluates air pollution controls for incorporation into the emissions planning process including current information on technology performance, cost, and operational constraints.

Commercially Available Control Technologies

WPL monitors and evaluates the current status of emissions control technology performance through trade organizations, emissions control equipment suppliers, and engineering design firms that support the installation of emissions control equipment. The information WPL receives from these parties assists in determining appropriate emissions control options to include and use in emissions planning. This information is useful for long-term strategic planning. Once long-term strategic emissions plans are approved, technical staff proceeds with preliminary engineering necessary to make the final selection of plant and unit-specific emissions controls.

Physical and Operational Constraints

Each power plant site and electric generating unit is unique in its configuration. This can present specific engineering and design challenges that must be considered in the emissions planning process such as current emissions control equipment performance, physical space available for new emissions controls, necessary equipment upgrades to support emissions controls such as the need for increased fan power, and required maintenance to reliably operate new controls. In addition, other operational considerations during emissions controls construction include the potential need to shut down units for prolonged periods. WPL must coordinate its power plant outages with those of other regional power plant operators and the electric transmission system operator to ensure adequate power is available during these outage periods. The engineering services group defines possible timing of control installation, including planned outages, given other power plant maintenance activities, to assure the continuation of reliable and cost-effective utility operations during emissions control installation. The construction schedule for installation of SCR on Edgewater Unit 5 is designed to minimize unnecessary tie-in outage time.

### 3.2.4 Planning for Air Emissions Regulatory Requirements

Multi-emissions planning requires evaluating future air emissions regulations and understanding associated impacts to WPL utility operations. Understanding the regulatory framework governing current, forthcoming, and future air emissions requirements is necessary to understand how to develop a flexible multi-emissions strategy that can change in response to changes in air emissions requirements. Due to the changing nature of air emissions requirements, WPL needs to continually monitor and remain informed about their current status. This section discusses current regulations and future policy development for air emissions requirements and WPL's consideration of these regulations for emissions planning to develop reduction scenarios.

The Clean Air Act (CAA) directs the EPA to establish regulatory requirements to address various pollutants throughout the United States. This ensures that all citizens have the same basic health and environmental protections. The CAA recognizes that states are often better positioned to carry out certain, specific requirements due to their knowledge of local industry and air quality conditions. Wisconsin implements many requirements of the CAA within state borders. Wisconsin assumes this responsibility by developing and complying with state implementation plans (SIPs) that document the collection of regulations the state will use to ensure air quality is maintained and CAA requirements are met.

The states must involve the public, through hearings and opportunities to comment, in the development of each SIP. The EPA must approve each SIP; if a SIP is deemed not acceptable, the EPA can assume enforcement of the applicable CAA provisions in that state by issuing a federal implementation plan (FIP). If an FIP is imposed, the FIP governs applicable regulatory requirements in a state until the SIP is approved. Once a SIP is approved, the SIP outlines the state's requirements that will serve to implement the relevant CAA provisions. The Wisconsin Department of Natural Resources (WDNR) is the primary regulatory agency that implements the CAA requirements in Wisconsin.

As part of the basic framework under the CAA, the EPA is required to establish NAAQS, which serve to protect public health and welfare. These standards address six criteria pollutants: nitrogen oxides (NOx), sulfur dioxide ($SO_2$), particulate matter (PM), ozone, carbon monoxide (CO), and lead. Combustion of fossil fuels from power plant boilers results in direct air emissions of NOx, $SO_2$, CO, and PM. In addition, emissions of nitrates and sulfates react as fine aerosols in the atmosphere to create fine particulate matter also known as PM less than 2.5 microns in diameter ($PM_{2.5}$). Ozone is not directly emitted from power plants, but results from the photochemical reaction of certain pollutant emissions, including NOx in the atmosphere.

The SIP specifies the regulations that each state will utilize to maintain NAAQS and related CAA requirements. Areas that comply with NAAQS are considered to be in attainment whereas routinely monitored locations that do not comply with these standards may be classified by the EPA as non-attainment and require further regulatory requirements. The CAA regulatory framework imposes emission requirements beyond those developed to meet the NAAQS. The operating service area of WPL is currently in attainment with all NAAQS with the exception of Sheboygan County[4], where Edgewater Unit 5 resides, which is currently classified as moderate non-attainment for the 1997 8-hour ozone standard.

The following sections summarize the status of current state and federal air regulations and how they apply to the Edgewater Generating Station.

RACT

The RACT rule stems from the 2004 EPA designation of non-attainment of the 8-hour ozone standard in counties located in southern and eastern Wisconsin. In accordance with the CAA, Wisconsin developed a SIP that takes corrective measures for these counties to achieve attainment status. Accordingly, the WDNR promulgated NR 428, in which the RACT rule limits NOx emissions from stationary combustion sources in Kenosha, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan, Washington, and Waukesha counties.

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[4] The US EPA has proposed to designate six Wisconsin counties as non-attainment for the $PM_{2.5}$ NAAQS, including Columbia County where WPL's Columbia Generating Station resides. EPA is expected to make its final designation by December 18, 2008.

Compliance with RACT applies to individual combustion units; however, a facility-averaging plan can be utilized amongst units located in the non-attainment area. Phase I RACT compliance begins on May 1, 2009 and establishes unit-specific emissions limits of 0.20 lb/MMBtu and 0.15 lb/MMBtu for small (Edgewater 3) and large (Edgewater 4 and 5) boilers, respectively. Phase II RACT compliance takes effect on May 1, 2013 and establishes unit-specific emissions limits of 0.15 lb/MMBtu and 0.10 lb/MMBtu for small and large boilers, respectively. Under a facility-wide averaging plan, an emission limit is established based on each unit's specific NOx emissions limit and heat input contribution to the facility as a whole. The result is a weighted average NOx emissions limit. Under RACT, emissions allowances can not be purchased or traded via a "cap-and-trade" model.

Clean Air Interstate Rule (CAIR)

In 2005, the EPA issued the Clean Air Interstate Rule (CAIR), requiring reductions of $SO_2$ and NOx emissions from existing and new electric generating units with greater than 25 MW of capacity. The CAIR rule was based on a cap-and-trade market-based program to reduce the regional transport of electric utility emissions to non-attainment areas in the eastern U.S. On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit vacated CAIR in its entirety. As of the filing of this application, the court has not issued the mandate in the case effectuating its order and is currently considering several petitions for rehearing. The court's decision and the continuing developments in the case create some uncertainty regarding CAIR's NOx and $SO_2$ emissions requirements. However, the recent CAIR vacatur neither affects the RACT rule nor the necessity to install emissions controls on Edgewater Unit 5. Moreover, WPL believes that any regulations succeeding CAIR will be at least as stringent as CAIR.

Clean Air Visibility Rule (CAVR)

The EPA issued the Clean Air Visibility Rule (CAVR) in 2005 to address regional haze. CAVR requires states to develop and implement SIPs to address visibility impairment in designated national parks and wilderness areas across the country with a national goal of no impairment by 2064. Affected states, including Wisconsin, were required to submit a SIP to the EPA to include Best Available Retrofit Technology (BART) air pollution controls and other additional measures needed for reducing state contributions to regional haze. The implementation of the CAVR SIP reductions is scheduled to begin to take effect in 2014 with full implementation before 2018. Generating facility emissions of primary concern for BART and regional haze regulation include $SO_2$, NOx and PM. Under CAVR, states slated to participate in CAIR's cap-and-trade program could determine that CAIR has precedence over BART. Wisconsin was scheduled to comply via this method; however, the recent vacatur of the CAIR regulation leaves Wisconsin's compliance strategy to CAVR currently undefined. WPL must provide BART-analyses to the Wisconsin DNR by January 9, 2009 for BART-eligible units. Edgewater Unit 5 is not a BART-eligible unit.

Mercury Emissions Regulations

In 2005, the EPA issued the Clean Air Mercury Rule (CAMR), which would require reductions of mercury emissions from existing and new U.S. coal-fired electric generating units with greater than 25 MW of capacity in a two-phased approach. CAMR would use a national cap-and-trade system, where compliance may be achieved by adding mercury controls and/or purchasing allowances. In February 2008, a court decision vacated and remanded CAMR to the EPA for reconsideration. The EPA's response to this court decision and associated implications to WPL are uncertain at this time.

In 2004, the WDNR independently issued NR 446, a state-only mercury emission control rule that affects electric utility companies in Wisconsin. The 2004 Wisconsin mercury rule included a requirement to cap mercury emissions from major utilities beginning on January 1, 2008, with 40% and 75% reductions required by 2010 and 2015, respectively. The rule does not require a specific method or technology for mercury emissions reduction, thus allowing utilities to choose one that is both cost effective and best suited for its particular needs.

In June of 2008, the Wisconsin Natural Resources Board approved revisions to NR 446. These revisions, approved by the legislature in October of 2008, eliminate the 2008-2009 cap, maintain the requirement to reduce emissions by 40% by 2010 and increase the reduction required by 2015 to 90%. Present in this rule is an option to phase in the mercury reductions if companies reduce emissions of NOx and $SO_2$ as well. This phase in of retrofits would allow for mercury reductions of 70% reduction by 2015, 80% by 2018 and 90% by 2021.

WPL has already installed activated carbon injection at its Edgewater Unit 5 to assist it in complying with the currently existing state-only mercury control rule. In addition, WPL's Clean Air Compliance Program calls for the installation of a baghouse on Edgewater Unit 5 for greater than 90% mercury emissions reduction, should the current system not attain such levels of capture. The proposed installation is slated for 2014 in advance of the 2015 mercury rule deadline.

Future $CO_2$ Regulations

There is considerable debate regarding the public policy response that the U.S. should adopt regarding greenhouse gas (GHG) emissions. Initiatives to address CO2 emissions are underway at state, regional, and national levels. During its multi-emission planning, WPL reviews proposed GHG legislation and regulation to attempt to understand its impact on decisions regarding emission control projects.

WPL's parent company, Alliant Energy, acknowledges the potential of climate change and the forthcoming public policy that will encompass it. Accordingly, Alliant Energy maintains the following position on climate change:

- It is in the best interest of share-owners and customers that future efforts to reduce greenhouse gas emissions be guided by an effective, mandatory policy that is national in scope, integrates multiple sectors, provides planning certainty, and allows flexible compliance actions consistent with national energy policy requirements
- Alliant will continue to invest in energy efficiency and renewable energy
- Alliant will continue to participate in collaborative efforts to further the development of technological advancements in emissions controls and generation performance.

Alliant Energy's climate change position is guided by the following principles:

- Sufficient scientific evidence exists to support greenhouse gas emissions reduction efforts
- Technology solutions based on sound science are critical and should be developed
- Greenhouse gas reduction efforts should not be targeted at any single industry but rather at all sectors
- Alliant is part of the solution
- Economic growth and sustainable development is possible while also reducing greenhouse gas emissions.

Alliant Energy has strategically focused on the following areas to reduce greenhouse gases:

- Installation of commercially proven controls for air emissions and continued operational excellence to achieve further generating facility efficiency improvements
- Demand-side management including energy conservation programs
- Expansion of company-owned renewable energy sources
- Continued use of Purchased Power Agreements (PPAs) and investments that focus on lower or non-emitting generation resources
- Development of technology solutions through funding of collaborative research programs for advanced clean coal generation as well as potential options for carbon sequestration.

### 3.2.5 Select Air Emissions Compliance Plan

WPL's air emissions planning process creates cost-effective and feasible emissions control strategies considering available emissions controls including the cost and performance of the controls and needed emissions reductions. The selection process links available emissions controls provided by WPL's CACP engineering team with projected future air emissions of interest. Projected future emissions are based upon projected future generating unit output from the IRP reference base case and estimated emissions rates. Emission reduction projects are chosen by matching projected future emissions against various environmental compliance scenarios. The environmental compliance scenarios considered in emissions planning include current federal and state air quality standards, as well as more stringent outcomes associated with future federal and state regulations. The selection of an air emissions plan is completed on the basis of regulatory compliance, net present value of total cost, and feasibility of implementation and technology performance.

### 3.2.6 Implement Near-Term Tactical Responses for Regulatory Compliance

The air emissions planning process combines needed emissions reductions, available emissions controls, and other operational considerations to develop a long-term plan of multi-emissions controls to install on specific generating units at specific points in time. Long-term plans span 30 years or more. Shorter-term tactical plans span the immediate two to five-year period. Long-term plans assist in understanding the sensitivity of proposed emissions controls to differing environmental compliance scenarios and help prioritize investments in emissions controls. Shorter-term tactical plans help in the selection of specific emissions controls for detailed technical reviews, determine feasibility at a plant and unit-specific level, refine cost estimates, and update financial budgets. The air emissions planning process provides WPL with the flexibility to address regulatory uncertainty, technology improvements, and other changing business conditions when planning emissions controls investments. Due to the significant construction necessary to install air pollution controls, implementation of near-term tactical responses must occur as part of the longer-term strategy.

### 3.2.7 Review and Update Air Emissions Compliance Plan

The end result of WPL's air emissions planning process is a comprehensive multi-emissions air compliance plan. Plan recommendations are presented to the company's Strategic Planning Committee (SPC) for review and approval. WPL updates its multi-emissions air compliance plans annually as part of the overall strategic planning process. WPL may also update these plans in the interim due to significant changes in environmental regulations, emissions control technology performance or cost, regulatory requirements, or utility operating conditions.

## 3.3 Project Need and Alternatives Analysis

### 3.3.1 Project Need

The installation of SCR on Edgewater Unit 5 for NOx control is necessary to attain compliance with RACT requirements. SCR installation is the only method through which full RACT compliance can be achieved without decommissioning the unit, as allowances can not be purchased or traded under the RACT rule. Other available NOx control technologies implemented on Edgewater Unit 5 would not yield the necessary NOx removal efficiency for Phase II RACT compliance (see Section 6).

The installation of the SCR system on Edgewater Unit 5 plays a significant role in WPL's fleet-wide Clean Air Compliance Program and is in alignment with the company's pro-active, value-added driven compliance philosophy. Although the CAIR rule was vacated by the DC Circuit Court in July 2008, WPL fully anticipates the future will yield a similar, if not more stringent, federal or state rule in place for NOx emissions reductions, either through EPA promulgation or as a legislative modification or addendum to the Clean Air Act. It is anticipated that installation of SCR at Edgewater Unit 5 will assist in complying with future rules.

To date, WPL has been successful with NOx emission reduction projects at Edgewater as part of a voluntary emission reduction program. In 1999, the facility began reducing emission of NOx through the implementation of the Combustion Initiative and SmartBurn technologies. In addition, the facility has been participating in an ozone season NOx averaging plan under NR 428 since year 2003 and has consistently performed under the limits required by the rule. These NOx reduction projects and how they contribute to WPL's strategy for meeting RACT requirements through a facility-average plan are described below.

***NOx Control Technologies at the Edgewater Generating Station***

Given that WPL is able to comply with RACT by averaging Edgewater Generating Station's emissions on a facility-wide basis, it is important to understand the current NOx control technologies that are being installed and planned for at the Edgewater Generating Station and the impact of those technologies on achieving RACT compliance. The following summarizes NOx reduction technologies implemented to date as well as planned projects.

<u>Edgewater Unit 3</u>
WPL is currently installing selective non-catalytic reduction (SNCR) and rich reagent injection (RRI) technologies on Edgewater Unit 3, to be operational by December 31, 2008. The Edgewater Unit 3 SNCR/RRI project is an extension of the SmartBurn project approved by the PSCW in 2001 with the issuance of a CA (Docket 6680-CE-162). A revision to the CA reflecting the SNCR/RRI initiative was submitted to the PSCW in October of 2007 and was approved on December 10, 2007. WPL anticipates a 30-40% reduction in NOx emissions with a target achievable NOx emission rate of approximately

0.20 lb/MMbtu, as compared to the RACT required rates for a small cyclone boiler of 0.20 lb/MMBtu (Phase I) and 0.15 lb/MMbtu (Phase II). Edgewater Unit 3 NOx emissions reductions will assist the Edgewater facility in meeting its RACT Phase I and II facility-wide average NOx emissions targets. WPL considered SCR installation for Edgewater Unit 3 to be impractical based on cost and thus rejected an SCR on Edgewater Unit 3 from further consideration as a technology for RACT compliance.

Edgewater Unit 4
WPL is currently installing SNCR/RRI technologies on Edgewater Unit 4 to be operational by December 31, 2008. The Edgewater Unit 4 SNCR/RRI effort is an extension of the SmartBurn project approved by the PSCW in 2000 with the issuance of a CA (Docket 5-CE-114). A revision to the CA reflecting the SNCR/RRI initiative was submitted in October of 2007 was approved on November 28, 2007. These technologies have been pilot scale tested on the unit in early 2008 as a precursor to the full scale installation. The SNCR/RRI modifications are anticipated to yield a 30-40% reduction in NOx emissions with a target achievable NOx emission rate of approximately 0.11 lb/MMBtu, as compared to the RACT-required rates for a large cyclone boiler of 0.15 lb/MMBtu (Phase I) and 0.10 lb/MMBtu (Phase II). Edgewater Unit 4 NOx emissions reductions will assist the Edgewater facility in meeting its Phase I and II facility-wide average requirements.

Edgewater Unit 5
WPL has installed SmartBurn technology, consisting of Low NOx Burners (LNB) and Separated Overfire Air (SOFA) technology, on Edgewater Unit 5 as a part of the Combustion Initiative projects to reduce NOx emissions at the site. These technologies have resulted in a 31% reduction of NOx emissions from Edgewater Unit 5, from 0.229 lb/MMBtu down to 0.16 lb/MMBtu.

As outlined in this application, WPL is planning the installation of SCR technology for the Edgewater Unit 5 facility and anticipates a 75% reduction from baseline NOx emissions (0.229 lb/MMBtu) combined with SmartBurn technology, with a target emission rate of 0.06 lb/MMbtu. The RACT rates required for a large wall-fired boiler are 0.15 lb/MMBtu (Phase I) and 0.10 lb/MMBTU (Phase II). Prior to SCR installation, Phase I RACT requirements will be met through a facility-wide NOx emission averaging plan. With the SCR installation, Edgewater Unit 5 will be able to meet unit -specific Phase II RACT NOx emission rate requirements, and will contribute to facility-wide NOx emission averaging for the purposes of complying with RACT Phase II requirements.

### *RACT Compliance Scenarios*

WPL has conducted an analysis of possible NOx control technologies for Edgewater Units 3, 4, and 5 for compliance with Phase I and Phase II RACT requirements under a facility-wide averaging plan.[5] Five scenarios of possible NOx controls installed at each unit were analyzed. Table 4 shows possible NOx emissions scenarios with SNCR/RRI NOx controls installed on Edgewater Unit 3 and various combinations of controls installed on Edgewater Units 4 and 5. This table shows that the SCR on Edgewater Unit 5 is necessary to meet Phase II RACT requirements, as scenarios without it (Scenarios 1 and 3) do not result in facility Phase II compliance, indicated by a negative compliance margin.

[5] The facility-wide emissions average was calculated using the heat input from the past five years (2003-2007) for each unit in conjunction with projected emission performance rates based on various controls installed at each unit.

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*Table 4. NOx Emissions and RACT Compliance Summary at the Edgewater Generating Station[a]*

| Scenario 1: Current and Approved Operation | | | | | |
|---|---|---|---|---|---|
| Controls Installed | | SNCR/RRI | SNCR/RRI | SOFA | Compliance Margin |
| Year | Estimated Facility Limit (lb/MMBtu) | Edgewater Unit 3 (lb/MMBtu) | Edgewater Unit 4 (lb/MMBtu) | Edgewater Unit 5 (lb/MMBtu) | |
| 2009 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2010 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2011 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2012 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2013 | 0.105 | 0.20 | 0.11 | 0.16 | -36.6% |
| 2014+ | 0.105 | 0.20 | 0.11 | 0.16 | -36.6% |
| **Scenario 2: SCR Installed on Edgewater Unit 5 (As Proposed in this CA Application)** | | | | | |
| Controls Installed | | SNCR/RRI | SNCR/RRI | SOFA and SCR (2012) | Compliance Margin |
| Year | Estimated Facility Limit (lb/MMBtu) | Edgewater Unit 3 (lb/MMBtu) | Edgewater Unit 4 (lb/MMBtu) | Edgewater Unit 5 (lb/MMBtu) | |
| 2009 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2010 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2011 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2012 | 0.155 | 0.20 | 0.11 | 0.06 | 39.2% |
| 2013 | 0.105 | 0.20 | 0.11 | 0.06 | 10.5% |
| 2014+ | 0.105 | 0.20 | 0.11 | 0.06 | 10.5% |
| **Scenario 3: SCR Installed on Edgewater Unit 4** | | | | | |
| Controls Installed | | SNCR/RRI | SNCR/RRI and SCR (2013) | SOFA | Compliance Margin |
| Year | Estimated Facility Limit (lb/MMBtu) | Edgewater Unit 3 (lb/MMBtu) | Edgewater Unit 4 (lb/MMBtu) | Edgewater Unit 5 (lb/MMBtu) | |
| 2009 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2010 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2011 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2012 | 0.155 | 0.20 | 0.11 | 0.16 | 7.5% |
| 2013 | 0.105 | 0.20 | 0.06 | 0.16 | -16.8% |
| 2014+ | 0.105 | 0.20 | 0.06 | 0.16 | -16.8% |

a. Edgewater Unit 5 NOx emissions presented are from the entire unit, both WEPCO's and WPL's shares. Although WEPCO plans to separate its share of Edgewater Unit 5 NOx emissions from WPL's share of emissions for their RACT averaging plan for 2009, this is an annual decision and may change in future years such that WPL may have to account for all NOx emissions for Edgewater 5. For example, Scenario 2 would have a compliance margin in Phase II of 5.9% should WEPCO's share of Edgewater Unit 5 not be included.

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### 3.3.2 Alternative Analysis

1) Install Other NOx Control Technologies

WPL has considered a range of commercially available technologies for NOx removal at Edgewater Unit 5, including Rich Reagent Injection (RRI), Selective Non-Catalytic Reduction (SNCR), Hybrid SCR, and Full-size SCR. The SNCR and RRI do not yield NOx emissions reductions necessary to meet the RACT requirements for Edgewater Unit 5. The Hybrid SCR has not been commercially proven on a boiler as large as Edgewater Unit 5 and would likely require costly modifications to meet NOx emissions limits (an ammonia distribution system). Additionally, published removal rate from the Hybrid SCR system would only marginally meet RACT Phase II requirements. The SCR is the only technology capable of producing emissions low enough to comply with RACT Phase II requirements (see discussion in Section 6). Because other NOx control technologies can not reliably provide sufficient removal of NOx to meet RACT, those technologies were not included in the EGEAS analysis.

2) Retire Edgewater Unit 5

Retiring Edgewater Unit 5 was not deemed a practical decision as it is a relatively new baseload generating facility that ranks in the top 25 percent most efficient plants in Wisconsin in terms of plant heat rate. Retirement would require replacement of the generating capacity provided by Edgewater Unit 5, which, as shown by the EGEAS runs, would require a NPVRR premium of over [redacted] dollars for WPL's share of Edgewater Unit 5, versus installing an SCR on the unit. Continuing operation of Edgewater Unit 5 was deemed prudent compared to retiring the unit for the following reasons:

- An analysis comparing the Net Present Value Revenue Requirements (NPVRR) showed a benefit to control the unit in excess of [redacted] dollars versus retiring the unit (discussed in Section 3.4 below).
- The payback period of the SCR project, compared to retiring the unit, is approximately 6 years after operation of the SCR (Section 3.4).
- Edgewater Unit 5 is the newest baseload generating facility in the WPL fleet, with operations beginning in 1985. The unit has an expected remaining life of 45 years.
- Edgewater Unit 5 is an efficient power plant in terms of heat rate. It ranks in the top 25 percent in terms of heat rate and efficiency, when compared to similar power plants in Wisconsin.
- Edgewater Unit 5 is a robust and flexible power plant in terms of fuel flexibility, turn-up, and turn-down. This allows the unit to follow load requirements, reducing the amount of emissions during periods of low electrical usage. The operation of Edgewater Unit 5 is unique and integral to the overall strategic operations of WPL.
- Edgewater Unit 5 is on schedule to meet current mercury control rules. It operates an activated carbon injection system and, if needed, may install a

baghouse to meet the 90% mercury emissions reduction required under the revised state mercury rule.

### 3.4 EGEAS Modeling Summary

As discussed in the above sections, in order to work toward achieving RACT Phase II compliance, decommissioning Edgewater Unit 5 is the only alternative to controlling NOx by SCR on Edgewater Unit 5. Therefore, WPL conducted a cost/benefit analysis on the SCR installation with the comparison of two EGEAS cases[6]:

- Installation of SCR NOx emissions control at Edgewater Unit 5 pursuant to the RACT requirements (base case)
- The retirement of the Edgewater Unit 5 facility (alternative case)

The two EGEAS cases are summarized in Table 5. The EGEAS runs showed an economic benefit of controlling the unit versus retiring the unit in excess of [redacted] for WPL's share of the project. Table 5 also includes NPVRR for an additional scenario that includes the installation of a baghouse and scrubber on Edgewater Unit 5.

*Table 5. EGEAS Analysis Results**

| EGEAS Run | NPVRR ($ MM) | Savings Versus Retirement ($ MM) |
|---|---|---|
| Base Case: Install SCR | [redacted] | [redacted] |
| Alternative Case: Retire Edgewater 5 in 2012 | [redacted] | |
| Installation of FGD and baghouse in 2014[a] | [redacted] | [redacted] |

* This table summarizes the modeling results for WPL's share of the project.
a. Modeled for informational purposes to demonstrate NPVRR for unit with installed controls for NOx, Hg, PM, and $SO_2$

In recognition of the various requests of the Commissioners in Wisconsin Electric Power Company Docket No. 6630-CE-299, WPL is providing in Appendix D several additional EGEAS scenarios modeling its share of the project.

### 3.5 Need and Alternatives Analysis Summary

The installation of an SCR on Edgewater Unit 5 serves to reduce NOx emissions on the unit to comply with RACT requirements. This SCR will also contribute to a facility-wide averaging of NOx emissions for the purposes of complying with RACT at the Edgewater Generating Station. Based, in part, on the EGEAS runs that WPL conducted, WPL has concluded that the installation of an SCR on Edgewater Unit 5 is a prudent alternative to retiring the unit. Buying NOx allowances is not an alternative under NR 428 RACT requirements, and in order to meet the limits set forth in the RACT rule, the SCR technology is the sole technology available to do so for Edgewater Unit 5. The EGEAS

[6] The EGEAS runs were conducted prior to the oral decision in PSCW Docket No. 6680-CE-170, and were based upon the updated IRP used in that case.

runs for WPL's share show that installing the SCR on Edgewater Unit 5 has a benefit of over [redacted] in NPVRR when compared to retiring the unit. For the reasons previously stated, WPL has determined that this project is both prudent and necessary for meeting current regulatory requirements and continuing to provide cost effective electricity generation to WPL's customers.

The additional EGEAS scenarios, which were modeled in response to the requests in Docket No. 6630-CE-299, show a benefit in NPVRR to the installation of an SCR on Edgewater Unit 5, in comparison to retiring the unit, under each modeled future, including when $CO_2$ is monetized and under a carbon-constrained future.

# 4.0 Operating Parameters

## 4.1 Cost of Operations

Table 6 provides a preliminary breakdown of fixed and variable operating parameters for the SCR system to be installed on Edgewater Unit 5. The operating and maintenance estimates are based on information from vendors of SCR systems and on Edgewater Unit 5 burning the current fuel, PRB coal. Fixed operating parameters are based on operating and maintenance typical of an SCR of this size and operating capability.

*Table 6. Edgewater Unit 5 SCR Operating Parameters*

| Operating Parameter | Edgewater Unit 5 SCR Value | Units |
|---|---|---|
| Plant Gross Rating | 430 | MW |
| Annual Capacity Factor | 71 | % |
| Flue Gas Flow at Economizer Outlet | 2,085,000 | acfm @ 700°F |
| Existing NOx Controls | LNB and SmartBurn | |
| SCR NOx Removal Efficiency | 75 | % |
| SCR outlet NOx Emissions | 0.06 | lb/MMBtu |
| Reagent Required | 19% Aqueous $NH_3$ | |
| Reagent Consumption | 1,600 | lbs/hr |
| Catalyst Life | 24,000 | Hours of SCR Operation |
| Catalyst Volume | 10,700 | $ft^3$ |
| Atomizing Air Requirement | 210 | scfm |
| Steam | 5,700 | lbs/hr |

Fixed and variable operating costs are based on the consumption rates presented in Table 6 and the following assumptions: 19% aqueous ammonia reagent cost of $180/ton, catalyst cost of $145/ft$^3$, steam cost $3.86/1,000 lb steam. The total annual operating cost is expected to be approximately $1,736,000 (in 2007 dollars).

## 4.2 Operating Characteristics

Installation of the SCR system on Edgewater Unit 5 will have impacts on the operation of the unit. The most significant items are as follows.

<u>Boiler Furnace Pressure Transients and ID Fans</u>
The existing furnace pressure at Edgewater Unit 5 does not require reinforcement of the furnace with addition of the SCR on Edgewater Unit 5. The existing ID fans operate at ~80% capacity at maximum operating load (430 MW). It is anticipated that the addition of the SCR will increase draft losses approximately 8" w.g. and the existing ID fans would operate at 95% capacity. In order to ensure adequate fan margin, modifications or replacement fans may be necessary. A detailed evaluation of possible fan modifications will be finalized after selection of the SCR technology supplier.

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Process Control
The SCR system requires new controls to be added and integrated into the operator interface in the existing control room. Plant personnel will require training on all new equipment and controls.

Materials Handing System
Ammonia delivery and preparation will require a moderate amount of operator involvement. The 19% aqueous ammonia will be delivered by truck, stored, and injected into the SCR system by atomization injection.

Truck and/or Rail Traffic
Truck traffic will increase slightly because of the delivery of ammonia reagent for the SCR system. It is not expected that rail traffic will be impacted by operation of the SCR.

Plant Operating Personnel
Existing personnel are expected to operate and maintain the new equipment.

Instrument Air
The SCR air system will tie into the existing instrument air system on site, and will include new air compressors and dryers to service the SCR atomizing air requirement, sonic horns, and ammonia tank farm.

Chemical Hazards
Ammonia is the primary chemical required for operation of the SCR system. In order to reduce hazardous chemical handling on-site, the project is using 19% aqueous ammonia (compared to the alternative anhydrous ammonia). The aqueous reagent will be delivered to the site by truck and transferred to storage tanks from an unloading station with a breakaway stand. Additionally, the ammonia injection system will be provided with an Emergency Stop (E-Stop) system which terminates ammonia feed to the SCR reactor either from automatic leak detection or upon operator command. Ammonia tanks will be equipped with emergency relief valves and manual shut-off valves for tank fill and supply openings.

Auxiliary Power Consumption
The new SCR system will add approximately 1,600 kW of auxiliary power required for running Edgewater Unit 5. The auxiliary power is for additional ID fan power required to overcome the pressure drop, and a smaller amount for balance of plant motors.

## 5.0 Description and Cost of Property Being Replaced

The current project layout and general arrangement of the SCR system was developed to improve constructability, reduce length of equipment tie-in outages and reduce relocation and demolition work. As it is currently planned, the only existing equipment anticipated to be removed as part of the Edgewater Unit 5 SCR project are the decommissioned acid tanks on the west side of the turbine building. This is to be the location of the ammonia storage and supply system. The net book value of the decommissioned acid tanks is approximately $5,000. No other existing equipment or structures are anticipated to be demolished or replaced as part of the Edgewater Unit 5 SCR project.

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## 6.0 NOx Reduction Technology Selection

WPL's compliance plan includes installation of NOx control at Edgewater Unit 5 to meet RACT requirements. Various commercial NOx reduction technologies were reviewed for application at Edgewater Unit 5, including feasibility of implementation on Edgewater Unit 5, ability to meet RACT requirements, and capital and operating cost considerations.

WPL has successfully lowered their NOx emissions at Edgewater Unit 5 by ~30%, down to 0.16 lb/MMBtu, by installing SOFA and low NOx burners (SmartBurn technology) in 2006. To meet RACT Phase II requirements, NOx emissions must be below 0.10 lb/MMBtu for the individual unit. To meet RACT Phase II requirements, an SCR was chosen for NOx reduction as it is the single proven technology commercially available that can achieve the level of NOx removal required.

### 6.1 Technology Selection Process

The specific technology chosen to accomplish the goal of reduction emissions at Edgewater Unit 5 was determined by an analysis of the following:

- Available technologies
- Reliable, long-term NOx removal efficiencies achievable by each technology
- Specific costs for each technology at Edgewater Unit 5
- Implementation timeframes
- Lead times and availability of critical components
- Plant specific considerations (e.g. space or current plant equipment constraints).

Based on site requirements and already installed NOx control systems, the following technologies were evaluated for NOx reduction to meet RACT at Edgewater Unit 5: SNCR, Hybrid SNCR/SCR, and SCR.

#### 6.1.1 Technology Selection Analysis

Edgewater Unit 5 currently employs the SmartBurn LNB including SOFA, reducing NOx emissions by 30%, from 0.229 lb/MMBtu down to 0.16 lb/MMBtu. Table 7 summarizes the expected removal efficiencies on Edgewater Unit 5 with additional NOx removal technologies combined with existing SmartBurn technology controls.

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*Table 7. NOx Reduction Technologies Maximum Removal Efficiencies from Baseline Emissions at Edgewater Unit 5*

| NOx Reduction Technology | Stand Alone NOx Removal Efficiency[a] | Removal Efficiency Combined with SmartBurn[b] |
|---|---|---|
| SmartBurn – Low NOx Burners (LNB) including Separated Overfire Air (SOFA) | 30% | - |
| Rich Reagent Injection (RRI) | 30% | 50% |
| SNCR | 25% | 50% |
| Hybrid SCR[c] | 55% | 65% |
| Full-size SCR | 90% | 90% |

a. Stand alone removal efficiency indicates removal from baseline emissions from Edgewater Unit 5, 0.229 lb/MMBtu (assumes no SmartBurn technology installed).

b Technology removal rates achieved when combined with SmartBurn technology, consistent with removal from 0.229 lb/MMBtu (assuming SmartBurn technology installed on Edgewater Unit 5).

c. Hybrid SCR removal efficiencies stated in this table assume even distribution of ammonia reagent to the SCR catalyst.

To achieve the individual Edgewater Unit 5 Phase II RACT limit of 0.10 lb/MMBtu from the baseline 0.229 lb/MMBtu, a combined (with SmartBurn technology) removal efficiency of approximately 60% must be achieved. The removal efficiencies in Table 7 indicate that SCR and Hybrid SCR are the only technologies capable of achieving the required level of NOx removal on Edgewater Unit 5. However, Hybrid SCR is not a commercially proven technology.

Hybrid SCR combines ammonia injection in the boiler (SNCR) with installation of a catalyst downstream that makes use of the ammonia slip from the upstream SNCR. Although this system has shown 50-60% removal in demonstration tests, the system lacks sufficient operating experience to be considered commercially proven on a unit as large as Edgewater Unit 5. The major concern with this system is the ammonia distribution at the catalyst, which, if insufficient, would not only provide unacceptable NOx removal, but also allow for high ammonia slip. If a supplemental ammonia distribution system was included as part of the Hybrid SCR, then the system costs would be comparable to a full SCR system.

For the reasons stated above, the SCR technology was chosen as the desired technology for lowering NOx emissions at Edgewater Unit 5.

## 6.2 Technology Selection Summary

An SCR is the only commercially available control technology that can reduce Edgewater Unit 5 NOx emissions below the 0.10 lb/MMBtu limit required by RACT Phase II.

# 7.0 Environmental Impacts/Permits

## 7.1 Maps and Drawings of Proposed Project and Site

The proposed project location and preliminary site layout for the project are shown in section 1, on Figures 1 and 2. The general site layout is also shown in Attachment A.

## 7.2 Proximity to Floodplains

The area for the location of the Edgewater Unit 5 SCR project is not within a floodway or 100-year floodplain.

## 7.3 Information on Applicable Environmental Factors

Several environmental factors have been considered for the proposed SCR project. The studies performed include the following:

- Archaeological and historic resources
- Threatened or endangered species
- Solid waste
- Water resources
- Wastewater discharge

Additional information is found in the following sections.

### 7.3.1 Archaeological and Historic Resources

A study was performed in January 2008 by an independent consultant regarding the potential presence of cultural, archeological, and burial sites at the Edgewater facility. According to the study, there are no known archaeological or historic resources in the construction footprint of the project.

### 7.3.2 Threatened and Endangered Species

A study was performed in December 2007 by an independent consultant identifying potential threatened and endangered species at the Edgewater facility. According to the study, the potential exists to impact threatened, endangered, or special concern species on the Edgewater property, especially on the sand dunes along the lakeshore. These species include: red-shouldered hawk (*buteo lineatus*); piping plover (*charadrius melodus*); one-flowered broomrape (*orobanche uniflora*); thickspike (*elymus lanceolatus ssp. psammophilus*); American sea-rocket (*cakile edenntula*); Northern Mosaic Forest; and Southern Sedge Meadow.

However, construction of the SCR on Edgewater Unit 5 will occur on already developed WPL property with no adverse impacts to critical habitats for endangered, threatened, or special concern species. Appropriate Best Management Practices (BMPs) and erosion control techniques will be used to prevent impacts to habitats. Accordingly, no detrimental impact to threatened, endangered, or special impact species is expected.

#### 7.3.3 Solid Waste

The Edgewater Unit 5 SCR project will have minimal impact to the solid waste (i.e. fly ash) operations at the facility. Currently, bottom and fly ash is sold or trucked off-site to a company-owned landfill. The injection of ammonia into the flue gas, as part of the SCR process, may result in the entrainment of ammonia residuals in the fly ash. However, this is expected to be minimal and will not affect the end use of the fly ash.

#### 7.3.4 Water Resources

Plant water consumption will not increase with the addition of the SCR system.

#### 7.3.5 Wastewater Discharge

Plant wastewater discharge will not be affected by the addition of the SCR system.

#### 7.3.6 Air Quality Resources

Operation of the SCR can result in oxidation of sulfur dioxide ($SO_2$) to sulfur trioxide ($SO_3$) which combines with water vapor to form sulfuric acid mist (SAM). The Edgewater Unit 5 SCR preliminary design specification calls for low $SO_2$ to $SO_3$ catalyst to mitigate the potential for increased SAM emissions. Further review will determine whether or not SAM emissions will exceed the SAM Prevention of Significant Deterioration (PSD) threshold. If the threshold is expected to be exceeded, WPL will conduct a formal PSD review.

### 7.4 List of Permits and Approvals Needed

Table 8 provides a list of permits and approvals that may be required for the project.

*Table 8. List of Required Permits and Approvals*

| Item | Agency | Planned Activity | Type of Approval |
|---|---|---|---|
| 1 | PSCW | Replacement, modification, or addition at a generating plant with cost greater than $7.9 million | Certificate of Authority |
| 2 | Wisconsin Department of Natural Resources (WDNR) | Construction, installation, or alteration of an air pollutant source | Air construction permit; air quality operation permit; PSD evaluation (contingent upon SAM emissions) |

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|---|---|---|---|
| 3 | WDNR | Discharge of storm water from construction sites impact one acre or more | WPDES General Storm Water Construction Permit |
| 4 | WDNR | Discharge of storm water from plant operations | Modify existing storm water pollution prevention plan |
| 5 | WDNR | Integrity testing of equipment | Hydrostatic Test Water Permit |
| 6 | Wisconsin Department of Commerce (WDC) | Construction - storm water management | Approval of Plan Summary Review Application and Submittal of Notice of Intent (per requirements of Comm 60) |
| 7 | WDC | Construction – revision of existing building | Approval of Plans and Specifications |
| 8 | WDC | Construction of plumbing facilities | Approval of Plans and Specifications |
| 9 | Wisconsin Department of Transportation (WDT) | Delivery of large/heavy components | Permit for the transportation of loads of excessive size and/or weight (Section 348.26(2) WI Stats.) |
| 10 | Sheboygan County | Delivery of large/heavy components | Permit for the transportation of loads of excessive size and/or weight (Section 348.26(2) WI Stats.) |
| 11 | City of Sheboygan | Construction | Building Permit (upon Commerce approval of Plans and Specifications) |
| 12 | City of Sheboygan | Delivery of large/heavy components | Permit for the transportation of loads of excessive size and/or weight (local ord.) |

## 8.0 Designation of Public Utilities and Others Affected

WPL has joint-ownership of Edgewater Unit 5. WPL owns 75% and WEPCO owns 25% of the Edgewater Unit 5 plant. The SCR project supports RACT compliance at the Edgewater Generating Station and will improve air quality in the ozone non-attainment area of Sheboygan County. By doing so, the project has potential to open the County to new industry and help promote economic development in the County.

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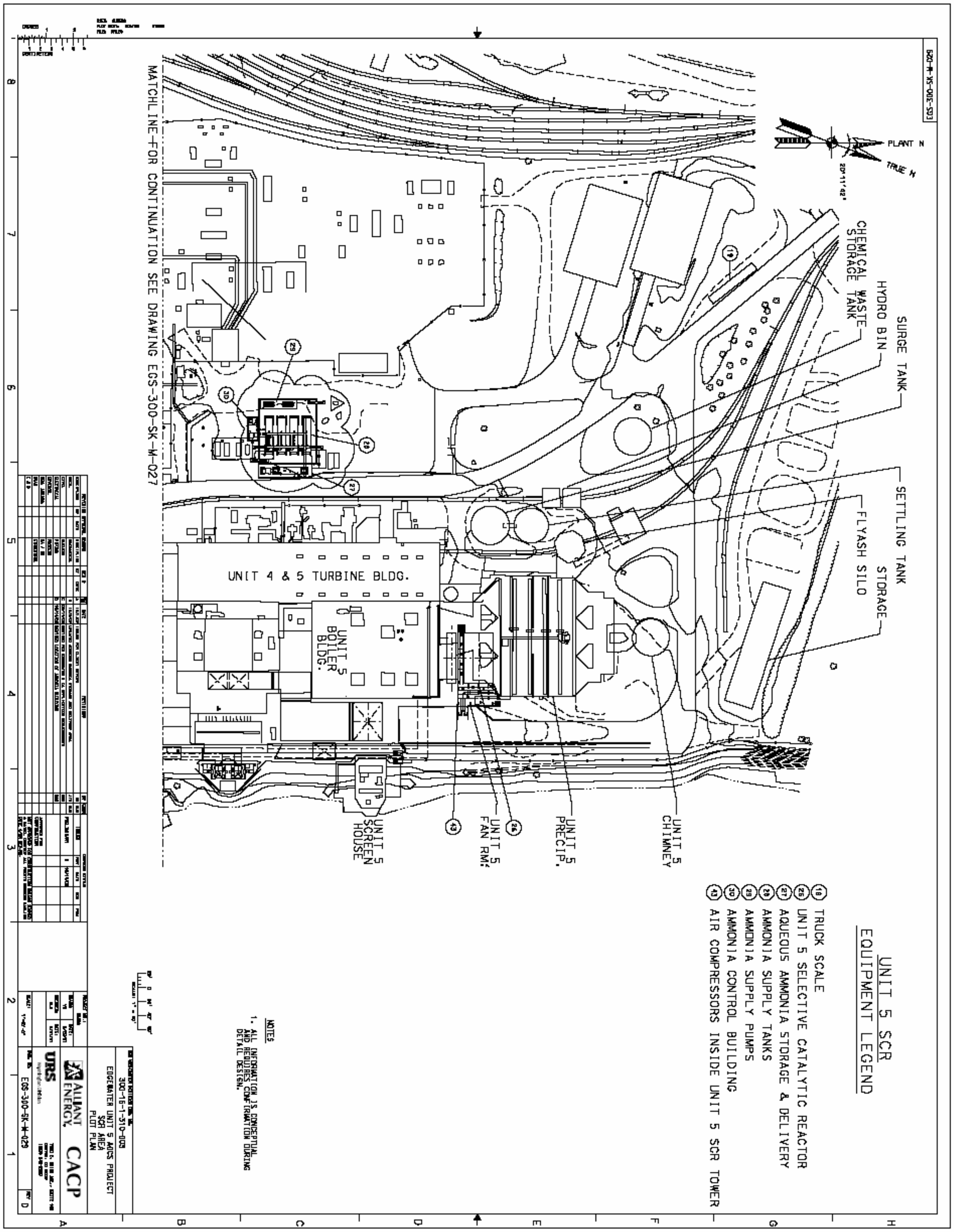
# Appendix A General Site Layout



# Appendix B NOx Technology Descriptions

Secondary or post combustion control systems are located downstream of primary combustion systems. They can be used independently or in combination with primary control systems. These processes typically use ammonia or urea to react with the NOx in the flue gas to reduce NOx to molecular nitrogen. The secondary control systems included in this section are Selective Catalytic Reduction (SCR), Selective Non-catalytic Reduction (SNCR), a hybrid combination of SCR and SNCR, and Rich Reagent Injection (RRI). Other secondary control technologies on the market at varying stages of development are not included in this evaluation due to their developmental status.

Selective Catalytic Reduction (SCR)

SCRs are generally designed for a maximum inlet gas temperature of 750°F. The SCR uses air taken from the air heater air outlet for ammonia dilution. Design temperature range is from 350°F to 600°F. In typical installations, the minimum acceptable flue gas temperature to maintain catalyst performance and eliminate problems with ammonia injection is approximately 550-600°F. The actual minimum load and gas temperature for the unit is determined on site-specific basis.

*Furnace Impacts* - The addition of the SCR increases the boiler gas side operating pressure drop. For balanced draft units, the static pressure in the duct at the air heater (gas side) and ID fan inlet will be more negative than under previous operating conditions. Gas-path pressure changes, including upset or excursion events due to addition of the SCR and the increase in ID fan head capability, are determined by evaluation of the current operating pressure, the design pressure, and a suitable margin below design pressure. Any new ductwork would be designed to current guidelines of NFPA 8502. More detailed analysis will need to be made during the design phase to determine whether structural reinforcement is necessary.

*SCR Reactor* - SCR reactor housing supports the catalyst modules on guide frames. The reactor assembly generally includes a catalyst removal system. A monorail system is used to move the catalyst into the reactor housing. The joints between modules are sealed to prevent flue gas bypassing the catalyst.

The following subsystems would be common for all units operating at a single site: ammonia delivery and storage, and ammonia transfer (pumps and piping that transport ammonia to the ductwork on inlet side of SCR reactor).

*Aqueous or Anhydrous Ammonia Reagent*– Anhydrous ammonia ($NH_3$) is designated to be a hazardous material that requires significant permitting and spill reporting paperwork. A tank rupture or major leak could result in a potentially life threatening environment for a large area of the plant site, and possibly extending beyond the boundaries of the plant. Many facilities have opted for the use of aqueous ammonia to avoid these issues. In the event of a spill, aqueous ammonia tends to keep ammonia in the solution, resulting in easier cleanup and a much smaller area that would be impacted within the plant. The major drawback of the use of aqueous ammonia is the added cost to ship all of the water along with the ammonia that is needed.

*Ammonia Injection System* - Each ammonia injection grid must be designed for even ammonia distribution across the face of the SCR catalyst. Some systems incorporate the capability to manually bias the ammonia injection to account for non-uniformity of NOx and flue gas flow at the SCR inlet. Others rely on upstream mixing devices to produce a uniform NOx and $NH_3$ distribution and computerized control systems to maintain the proper ammonia injection rates.

*Ammonia Atomizing Air Compressors* - Compressed air is used to atomize the ammonia. Dedicated skid mounted compressors are typically used for ammonia atomization.

*Dilution Air Fans* - Two 100% capacity dilution air fans will be provided for each SCR vaporization skid. The fans will be centrifugal type skid mounted assemblies. For each unit, dilution air fans will be designed for operation with 350°F to 600°F air, and the capability to withstand 750°F. The fan controls will have the capability to automatically start the standby fan on low air pressure. The source of dilution air is a takeoff on the air heater air outlet duct. The fans will be located with each vaporization skid.

*Flow Distribution* - Flow distribution devices, if necessary, will be provided to assure adequate flue gas and ammonia distribution and effective utilization of catalyst. The flow at the economizer exit is expected to be stratified and is likely to vary with load. Static and dynamic means of flow compensation may be required.

*Electrical Supply* - A common electrical supply system provides power to the ammonia pumps and controls. New electrical components will typically be necessary, including an MCC and new switchgear. Alarm/monitoring signals are wired to the nearest existing, continuously manned control room. The increased pressure drop may require that the existing ID fans be upgraded on some units, requiring new electrical connections for larger motors in some cases. The existing starters may be reused, and a new cable will be installed to the motor.

<u>Selective Non-Catalytic Reduction (SNCR)</u>

SNCR was originally developed in Japan in the 1970s for use on oil and gas-fired units. SNCR requires injection of ammonia or urea into the proper temperature window within the back pass of the furnace. The ammonia or urea reacts with NOx species to form nitrogen and water. Emission reduction capabilities range from15-20% at 5-ppm ammonia slip to 30% at 10-ppm ammonia slip in most commercial installations.

An SNCR system requires the installation of reagent storage and transfer equipment, a multilevel injection grid and the necessary control instrumentation. Due to the elimination of the catalyst used in the SCR process, the SNCR consumption rates for ammonia or urea are 3-4 times the rates required for an SCR system.

The gas temperature at the point of injection is critical to the NOx reduction performance of an SNCR system. This window falls in a range of 1600-2000°F with an optimum temperature of approximately 1800°F. Above this temperature, ammonia begins to thermally decompose and below this temperature, the reaction rate for NOx reduction decreases, resulting in increased ammonia slip. The temperature profile in any given boiler changes with fluctuations in boiler load. Therefore, the optimum injection point will move during cycling operation and multiple injection points will be required. It should also be noted that the longer the ammonia or urea stays within the optimum temperature window, the higher the NOx reduction that is achieved. Residence times in excess of one second are desirable to achieve the maximum reduction efficiency. The minimum residence time is approximately 0.3 seconds for moderate performance. However, most large utility boilers have heat transfer surfaces (pendants and platens) positioned in this flue gas temperature zone. This will reduce the effective use of the SNCR system, even if multiple injection levels are installed. In some cases, these internal obstructions will make the application of SNCR impractical.

Controlling the injection of the ammonia or urea is critical to performance of the SNCR system. Continuous ammonia slip measurements would allow direct control of the injection rates, but reliable equipment for ammonia measurement is not currently available commercially. The location of the injection ports must also consider the distribution of ammonia across the furnace cross section. Multiple injection zones and levels are typically required in a utility application to account for the large volume within a furnace.

One of the major problems associated with ammonia slip is the formation of ammonium bisulfate due to reaction with sulfur trioxide ($SO_3$) in the flue gas. This compound will precipitate at air heater operating temperatures and can lead to fouling and plugging. Also a concern is the formation of nitrous oxide ($N_2O$) during the SNCR reactions. Urea injection typically leads to higher $N_2O$ production rates. $N_2O$ formation rates increase as the rate of NOx reduction increases.

Additives and enhancers have been tested to improve SNCR performance; however, none are commercially available. Some are designed to maintain the temperature window (methane) while others are designed to lower the temperature at which the reaction will occur. The use of additives is not considered in the SNCR evaluation.

For SNCR installations, the actual NOx removal rate is strongly influenced by the carbon monoxide (CO) level in the injection zone. Variations in the CO concentration can move the temperature window where the urea reaction chemistry performs adequately. Therefore, unit load, burner firing pattern, and localized CO concentration are additional variables that increase the complexity of SNCR system control.

Hybrid SNCR/SCR

This system combines the NOx reduction capability of SNCR in the boiler with the installation of an SCR catalyst downstream that uses the ammonia slip from the SNCR process. The major problem with this process is adequate distribution of ammonia to the SCR catalyst. Control is difficult due to varying NOx distributions in the flue gas. Therefore, inlet NOx concentrations at the catalyst face may be much lower than design levels, resulting in ammonia passing through the catalyst without reaction. High local concentrations of NOx would have insufficient ammonia for reaction, resulting in reduced NOx reduction efficiency. Some hybrid systems will use a supplemental ammonia injection system to ensure sufficient ammonia feed to the SCR catalyst. If the injection system is required, then the cost for the total system will approach that of a full-scale SCR system.

NOx reductions typically fall in a range of 50-60% for this hybrid system, although some test programs indicate that up to 90% NOx removal is technically feasible with this combined system. The primary reason for including the hybrid design in any evaluation is the potential for cost savings versus a full-scale system. As the ammonia maldistribution increases downstream of the SNCR subsystem, the volume of catalyst required increases. At some point, the cost savings from reduced catalyst volume will be more than offset by the higher chemical feed costs associated with an SNCR system. The purpose of the hybrid design is to increase the SNCR removal efficiency from 30% to 50-60% while at the same time reducing the ammonia slip rates to 5 ppm or less and also reducing the ammonia or urea feed rate by 30% or more. Demonstration tests have shown the potential for this design, but it should not be considered a standard commercial offering.

Rich Reagent Injection

Rich Reagent Injection (RRI) is the process of injecting amine-based compounds into the fuel-rich regions of the furnace to reduce the formation of NOx. The RRI process was originally developed for coal-fired cyclone boilers, and performs well in the fuel-rich lower furnace created by operating cyclone boilers with Overfire Air. RRI is similar to selective non-catalytic reduction (SNCR), which injects urea into the furnace where the gas temperatures are between 1600$^{o}$F and 2000$^{o}$F. The RRI process, on the other hand, injects the urea at higher gas temperatures (2400$^{o}$F – 3100$^{o}$F) within the combustion zone of the lower furnace where the conditions are ideal for NOx reduction. RRI can reduce NOx by 40% and generally has low ammonia slip.

The RRI process, which can be licensed from Reaction Engineering International and the Electric Power Research Institute, is a complementary technology that can be coupled with other NOx reduction technologies such as low NOx burners, Overfire Air, and SNCR. The RRI process is particularly compatible with SNCR as it uses similar chemicals and hardware. Combined RRI and SNCR systems have demonstrated NOx reductions of 50%. The RRI process has been demonstrated at two full-scale utilities: Conectiv's 160 MW B. L. England Unit 1 and Ameren UE's 480 MW Sioux Unit 1.

# Appendix C Project Conceptual Design Scope Assumptions

| General Project Estimate | |
|---|---|
| **Project Description** | Retrofit NOx control SCR project. |
| **Type of Plant** | Utility grade reliability |
| **Design Fuel** | Current coal: Jacobs Ranch, 8,614 Btu/lb, 28% moisture, 5.6% ash, 0.45% sulfur. Design coal: Rosebud PRB, 9,154 Btu/lb, 25% moisture, 8.8% ash, 0.8% sulfur. |
| **Boiler Design Steam Pressure** | 2,400 psig |
| **Boiler Design Steam Temperature** | 1,000°F |
| **Operation** | Load Following with swings 430 MW |
| **Capacity Factor** | 71% |
| **Minimum Load Capacity** | 16% |
| **Project Location** | Edgewater Generating Station in Sheboygan County, along Lake Michigan |
| **Site Description** | Brownfield- with existing Unit 5, began commercial operation in 1985. Also at this site are Edgewater Units 3 and 4 (60 MW and 325 MW). |
| **Boiler Manufacturer** | Babcock & Wilcox |
| **Project Commissioning and Start-up Date** | Fall 2011 |
| **Cost Basis/Assumptions** | |
| **General** | |
| **Ammonia Supply** | |
| **Source** | 19% aqueous ammonia from remote source TBD |
| **Delivery** | Tank truck to site |
| **Storage** | Two 45,000 gallon horizontal, carbon steel, 30 psig design pressure bullet type tanks and one pre-assembled and pre-wired aqueous ammonia supply skid. |
| **Catalyst disposal** | Catalyst manufacturer to provide replacement catalyst will also be responsible for spent catalyst disposal. |
| **Site Conditions** | Adequate space to support additional equipment, with constraints existing due to access of existing roads and placement of existing plant equipment. |
| **Soil Conditions/Stability** | Soils are stable and require no further preparation in and around area suitable for use as laydown. |
| **Subsurface Rock** | Rock exists in the area. |
| **Dewatering** | Not anticipated to be required. |
| **Construction Storm water Control** | BMP will be employed during construction. |
| **Wetland Mitigation** | No wetlands exist in the area of proposed construction. |
| **Landscaping** | Minimal landscaping is required. Disturbed areas will be seeded for erosion control. |
| **Rail Access** | Existing spur on site may be used for receipt of equipment shipped by rail. |

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|---|---|
| **Truck Access** | Existing roads will be used for construction access. Temporary roads may also need to be used for transportation of equipment. |
| **Laydown Areas** | Sufficient space is available west of Lakeshore Drive in close proximity to the work area. |
| **Structural** | |
| **Soil Bearing Capacity** | Additional geotechnical information will be used to determine soil stability in specific areas of the SCR project. It is expected that the heavily loaded SCR support columns will require deep foundations. Other foundations needed for the ammonia storage area will likely be shallow foundations. |
| **SCR** | SCR and related stair towers and equipment will be enclosed with materials to match those used in the existing plant. |
| **Ammonia Storage** | Ladder and platform will be provided for access to the tanks and pump skids. |
| **Mechanical** | |
| **Pumps** | Sparing philosophy includes 2x100% for most applications. |
| **Compressed Air Supply** | From existing Edgewater Unit 5 air supply system. |
| **Fire Protection** | SCR structure will be provided with dry stand pipe for fire automatic fire suppression. |
| **Fire Detection** | A Main Fire Control Panel (MFCP) will be located in the Main Control room and will be provided input from new Local Fire Control Panels (LFCP) at the SCR electric shelter. |
| **Ammonia Handling** | Ammonia delivered as 19% aqueous ammonia solution by truck to storage tanks on site. |
| **Emissions Control** | |
| **Emissions Control** | |
| **NOx** | Existing combustion controls are installed – SOFA and LNB. Combined, these technologies reduce NOx to 0.16 lb/MMBtu. Current project is SCR installation on Edgewater Unit 5 to reduce outlet annual average NOx to 0.06 lb/MMBtu. |
| **$SO_2$** | Current limit is 1.2 lb/MMBtu 3-hr average |
| **Opacity** | 20% |
| **Hg** | 40% reduction required by 2010;<br>90% reduction is by required by 2015 |
| **Electrical** | |
| **Auxiliary Power** | Additional auxiliary power to SCR system will be supplied from existing available plant power. A new motor control center in the SCR is required, but new distribution transformers will not be required. |
| **Control System** | DCS tie-in with existing plant system. |
| **Plant Communications** | Dial telephone systems will be provided. Page-party systems will also be provided at operating and maintenance locations, equipment rooms, and major control locations. |
| **Construction** | |
| **Performance Testing** | Included for all components regardless of contracting approach. |
| **Stack Testing** | Included to meet RACT 428 NOx emissions requirements. |
| **Commissioning and Start-up** | Included |
| **Operator Training** | Included |

| | |
|---|---|
| **Construction Utilities** | |
| **Water Supply** | Water supply for construction will be from existing water supply. |
| **Construction Sanitary Facilities** | Construction personnel sanitary facilities will be portable facilities with wastes being removed and disposed of off-site via a portable vacuum truck. |
| **Construction Power** | Existing plant will provide construction power requirements. |
| **Equipment Delivery** | Major equipment may be received via existing rail. Minor equipment may be received via rail or tuck, whichever is more efficient. |
| **Construction Schedule** | It is assumed that the construction schedule will be adequate to allow the project to be completed with minimal overtime. Construction schedule will be estimated as a 5x10 schedule to incentivize labor. |
| **Construction Facilities** | Facilities (buildings) built to support construction will be mobile and removed after construction. |
| **Existing Facilities** | No relocation of existing facilities is anticipated at this time. |
| **Miscellaneous** | |
| **Permanent Plant Operating Spare Parts** | Allowance included assuming some amount of spares. |

# Appendix D Additional Requested EGEAS Runs

The following requests for further analyses were identified in the Concurrence to the Certificate and Order for pollution control equipment on the Oak Creek Power Plant, Docket No. 6630-CE-299:

A. A base case consisting of $CO_2$ monetization and the Renewables Portfolio Standard (RPS).
B. Potential future scenarios in which certain variables are modeled as variations, or bookends from the base case, namely:

    1) $CO_2$ costs based on:
        i) "Reputable current estimates from such sources as the Environmental Protection Agency (EPA) or the Pew Center on Global Climate Change to provide a reasonable range"
        ii) Start date of carbon controls
        iii) Emissions cap amount
    2) Natural gas prices at low, medium (base), and high levels and one scenario of high gas prices and low coal prices
    3) Coal prices at low, medium, and high levels
    4) Reserve margins at regional reliability entity recommendation and state level
    5) Construction costs at low, medium, and high levels
    6) MISO impacts, both selling into and buying out of the market with and without the proposed plants
    7) Demand and energy forecasts, updated for the next thirty years with low, medium, and high sensitivities
    8) Generation options as follows:
        i) The feasibility and availability of nuclear energy by 2020
        ii) No new coal generation
        iii) No new coal generation, but availability of nuclear energy by 2020.

C. An updated IRP "if it has been two years or more since the last IRP was filed with a Certificate of Public Convenience and Necessity Case."

The last request, item C in the above list, has been addressed since WPL is working from an updated IRP (May 2007) as filed and accepted as complete in Docket No. 6680-CE-170.

Tables 9 and 10, below, summarize additional EGEAS runs designed to address items A and B in the above list including the bookends described under item B. Table 9 describes the focus of each of the additional EGEAS runs while Table 10 summarizes the expansion plans associated with each of the additional EGEAS runs.

Table 9 presents a combination of three Plans and five Future Scenarios. Each one of the 15 cells in the table represents a single EGEAS run. Each EGEAS run's description may be determined by combining the information about its corresponding Plan and Future

Scenario. For instance, Plan 1, Future Scenario 2 (EDG5 P1F2) represents the net present value of the revenue requirement (NPVRR) analysis corresponding to the plan to install the SCR in 2011 under the base conditions plus monetized CO2 emissions using one of the PSCW staff price forecasts used in Docket No. 6680-CA-170, as well as nuclear generation available after 2020.

The specific details and purposes behind each of the Plans and Future Scenarios are described below. Please note that the *prima facie* case presented by WPL in the instant filing is based, in part, on an EGEAS base (EDG5 P1F1) and alternative (EDG5 P2F1) case *excluding* CO2 monetization, yet includes the current RPS standard. EGEAS run EDG5_P3F1 was modeled for informational purposes to demonstrate NPVRR for the unit with installed controls for NOx, Hg, PM, and SO2. The Concurrence in Docket No. 6630-CE-299 requested that the EGEAS base case consist of CO2 monetization and the RPS standard. The EGEAS run EDG5 P1F2, adds $CO_2$ monitization to the WPL base case.. Furthermore, the remaining runs attempt to capture the information requested in the Concurrence in Docket No. 6630-CE-299, and are not intended to represent WPL's proposals in this case.

Plans

Plans 1, 2, and 3 describe a range of actions that could transpire at Edgewater Unit 5:

- Plan 1 represents the installation of the SCR in 2011.
- Plan 2 represents retiring Edgewater Unit 5 at the end of 2012 instead of installing the SCR in 2011. As noted in the application, installing the SCR is the only alternative to comply with RACT.
- Plan 3 represents the installation of a bag house and scrubber in 2014 in addition to the installation of the SCR in 2011, as discussed in section 3.2.4 of the application.

Future Scenarios

The five Future Scenarios represent planning scenarios in which key variables are added or altered to test the robustness of the outcomes derived from analysis of the plans using the base case, Future Scenario 1.

Future Scenario 1, the base case, makes no revisions, additions, or alterations. Plans 1 through 3 combined with Future Scenario 1 are identical to those reported in Table 5 of the application.

Future Scenario 2 alters the base case by monetizing CO2 emissions using one of the PSCW staff price forecasts used in Docket No. 6680-CE-170. Nuclear generation will be available in this and Future Scenarios 3, 4, and 5 after year 2020 in the planning horizon.

Future Scenarios 3 and 4 represent conditions that would favor and disfavor the retention of Edgewater Unit 5, respectively. In these Future Scenarios, natural gas and coal fuel prices, purchased power prices, SO2 and NOx allowance prices, the costs to install the SCR, and demand and energy forecasts are varied to create these favorable and disfavorable conditions.

Future Scenario 5 represents a carbon-constrained, CO2 emissions monetized environment. Future Scenario 5 alters the base case by monetizing CO2 emissions using one of the PSCW staff price forecasts used in Docket No. 6680-CE-170 identical to the price forecast used in Future Scenario 2. When CO2 monetization begins, in 2015, natural gas prices increase and coal prices decrease with corresponding changes in purchase power market prices, as a result of changes in generation economic dispatch to reduce CO2 emissions. This future scenario also includes policy changes consistent with a carbon constrained environment including an enhanced RPS of 25 % renewables by 2025 and removal of the current production tax credit for wind generation.

MISO Impact Resulting from Changes to Availability of In-State Generation

This is a qualitative assessment of the MISO-related impacts related to changes in generation resources inside the Wisconsin Energy Market resulting from changes in the available set of in-state generation resources. The purpose of this assessment is to address bookend 6 in the above list regarding the impact of installing the SCR at Edgewater Unit 5 versus retiring the unit. As part of this assessment, it is important to understand the structure of the MISO market, drivers for cost impacts and the likely result of discrete, specific decisions that change system topology.

The MISO energy market, as provided for and operated pursuant to the MISO Transmission and Energy Market Tariff (TEMT), is generally designed to levelize the cost of energy (Marginal Energy component of Locational Marginal Price - LMP) across the MISO footprint through a centralized economic dispatch mechanism. At the same time, MISO recognizes and mitigates transmission overloading by redispatching generation resources, on an out-of-economic basis, which are economically suboptimal combinations of generation used to reallocate power flows, thereby reducing line loading to acceptable levels. The cost of this suboptimal redispatch is identified and charged to those generators and loads which are most directly responsible for the potential overloads through the congestion component of LMP. In essence, the LMP congestion component provides a cost signal to generators and loads which is intended to encourage a reduction of generation output at those locations where excess generation injections are creating transmission overloads while stimulating increased generation production at locations that additional generation would be beneficial to the transmission grid. Similar behavior is intended for load, although load is significantly less operationally flexible than dispatchable generation resources and in many cases unable to respond to the congestion-related cost signals.

From a historic perspective, generation, along with purchases and sales, was dispatched by a utility in order to serve its load directly. The objective function was to precisely meet a volumetric energy requirement while minimizing the cost to do so. Within the MISO market, MISO is responsible for the volumetric balancing of generation and load, while minimizing cost subject to reliability constraints. The utility buys its load requirements from MISO at the prevailing MISO market price, and sells its generation and transactional energy resources (purchases) to MISO in response to MISO's price signals, receiving payments from MISO based on the MISO LMP price (for purposes of this assessment, discussion of the MISO Day-Ahead vs Real-time markets is not considered.) In this market structure the revenue a utility receives from the sale of its generation into the market offsets the cost it must pay the market for the energy needed to serve its load. Ideally, the generation resource mix serves as a financial hedge against the cost of serving load.

MISO computes actual LMP price signals, both energy and congestion components (additionally a loss component) every five minutes in real-time, and also produces a binding Day-Ahead set of hourly LMPs used for financial settlement and unit commitment purposes. However, MISO does not produce either a binding longer-term set of LMP prices or a non-binding public forecast of LMP prices that could be used to accurately site new generation or loads. Neither does MISO publicly produce an LMP analysis that could be used by generation producers to reasonably predict the cost impact that might result from discrete additions of transmission equipment. In fact, there are no publicly available, long-term plans for new transmission that are definitive largely due to the uncertainty of siting authorization and the associated resulting design, timing and cost of any potential transmission additions.

In essence, the MISO LMP prices only provide an extremely short-term price signal. Every change in system topology (load levels, transmission availability and additions and generation additions, retirements and availability) impacts LMP prices, and information relating to most of these possible changes are not available to most market participants more than a short time in advance, if at all. As a consequence, it is extremely difficult to reasonably predict market prices or conditions more than a short time into the future with any degree of accuracy. However, it is possible to qualitatively describe the likely impact on prices that would result from a singular change to the topology of the system, recognizing that subsequent unforeseen and unrelated changes to the system may result in additional cost impacts that reverse the effect of such change.

With respect to the question of whether the public is better served by deploying additional capital to enhance environmental controls at Wisconsin-based generators, in this case Edgewater Unit #5, or to retire that generator and consider alternate capacity and energy supplies, it is reasonable to consider the impact on the price of energy in the Wisconsin portion of the MISO footprint. Wisconsin generally, and the WUMS portion of the state in particular is relatively isolated from the rest of MISO due to transmission limitations. In fact, WUMS is presently identified as a Narrowly Constrained Area (NCA) within MISO, a designation that recognizes these limitations and imposes pricing restrictions to prevent market abuses. Because of limitations to Wisconsin's import capability, most of Wisconsin's power requirements need to be served by generation that originates from within the state in order to avoid extreme congestion risk or jeopardize system stability. The reduction of available generation, particularly that produced by relatively low cost resources such as coal-fired facilities, would have the effect of either increasing the amount of out-of-state energy that would be produced and imported to serve the electric load in Wisconsin, or increasing in-state production by more expensive resources.

Increased out-of-state supply would result in greater transmission loading, which would create a need for further economically sub-optimal redispatch to mitigate this transmission loading, and therefore result in increased congestion costs within Wisconsin. This is the logical result of MISO sending a cost signal seeking to increase the amount of generation produced inside the state. However, if there is no additional generation available inside the state, the LMP costs will rise until MISO is no longer able to mitigate transmission overloads, at which point MISO will simply require load curtailments. It is important to note that as LMP congestion charges rise, remaining in-state generation will receive a higher level of revenue for the generation it does produce. But the entire load in the same area will also experience this cost increase, and since the available generation will be less than before the targeted generator is retired, there will be a reduction in the overall hedge value of the generation, and the cost paid by electric customers will likely increase. At the same time that the LMP price inside the state increases due to congestion impacts, LMP prices outside of the state will drop as power from those areas is priced by MISO at lower levels in order to encourage reduced generation so as to reduce the power flows that are creating the overloading. Therefore, power purchased from out of state resources becomes a progressively less valuable offset to the higher cost being paid by Wisconsin loads.

In the short-term, higher cost peaking generators inside the state will be able to respond to the MISO cost signals and produce higher levels of energy output, raising costs but avoiding outages. Over time, however, as this peaking generation becomes more fully deployed for baseload needs, the state will exhaust its available supplies, the LMP prices will rise as driven by transmission-related congestion, and load curtailments will become commonplace.

To present a balanced view of the future, it needs to be recognized that the above scenario will inevitably occur regardless of near-term environmentally driven retirements simply as a result of normal load growth without associated expansion of dispatchable baseload resources, much of which needs to be located within the state. However, the situation will present itself much more quickly if existing efficient baseload generation is retired prematurely, particularly large facilities such as Edgewater #5. The effect of the reduction of a single generator is very difficult to quantify, but there is no question, qualitatively, on the directional impact of prices within MISO or the WUMS portion of the state. The possibility that multiple baseload generators, representing a significant percentage of Wisconsin's baseload fleet, could be retired in the near future raises serious questions about the cost of electric service and service reliability in Wisconsin.

**REDACTED**

*Table 9. Additional EGEAS Runs*

| | | Future Scenarios* | | | | |
|---|---|---|---|---|---|---|
| | | **Future 1**<br>**Base Assumptions**<br>**No Monetized**<br>**CO2 Allowances** | **Future 2**<br>**Base Assumptions and Monetized**<br>**CO2 Allowances**<br>-Based upon Staff's NED 3 CO2 ramp approach ($10/ton beginning in 2015, ramping to $25/ton in 2025 (2008 dollars))<br>-Nuclear Available after 2020. | **Future 3**<br>**High Retention Value**<br>-Gas prices high<br>-Coal prices Low<br>- Purchase power market prices consistent with gas prices<br>- SO2 allowance prices at current market rates<br>- Project costs are 10% below the estimate<br>- Nuclear Available after 2020 | **Future 4**<br>**Low Retention Value**<br>-Gas prices low<br>-Coal prices high<br>- Purchase power market prices consistent with gas prices<br>- SO2 allowance prices at high rates (SO2 and NOX cost levels prior to vacation of CAIR)<br>- Project costs are 20% above the estimate<br>- | **Future #5**<br>**Carbon Constrained Future**<br>**Beginning with CO2 Monetization in 2015:**<br>**-CO2 Monetized at Future 2 levels**<br>-Gas prices high, corresponding with CO2 monetization<br>-Coal prices low, corresponding with CO2 monetization<br>- Purchase power market prices cons |
| Plans | **Plan 1:**<br>**Install SCR in 2011** | [redacted]<br>**P1F1**<br>(EDG5_45_P1F1) | [redacted]<br>**P1F2**<br>(EDG5_45_P1F2G) | [redacted]<br>**P1F3**<br>(EDG5_45_P1F3C) | [redacted]<br>**P1F4**<br>(EDG5_45_P1F4C) | [redacted]<br>**P1F5**<br>(EDG5_45_P1F5C) |
| | **Plan 2:**<br>**Do not install SCR and retire Edgewater Unit 5 at the end of 2012** | [redacted]<br>**P2F1**<br>(EDG5_12_P2F1) | [redacted]<br>**P2F2**<br>(EDG5_12_P2F2G) | [redacted]<br>**P2F3**<br>(EDG5_12_P2F3C) | [redacted]<br>**P2F4**<br>(EDG5_12_P2F4C) | [redacted]<br>**P2F5**<br>(EDG5_12_P2F5C) |
| | **Plan 3:**<br>**Install SCR in 2011 and Bag House and Scrubber in 2014** | [redacted]<br>**P3F1**<br>(EDG5_BH_P3F1) | [redacted]<br>**P3F2**<br>(EDG5_BH_P3F2E) | [redacted]<br>**P3F3**<br>(EDG5_BH_P3F3C) | [redacted]<br>**P3F4**<br>(EDG5_BH_P3F4C) | [redacted]<br>**P3F5**<br>(EDG5_BH_P3F5C) |

* NPVRR values stated in table cells are in millions of 2005 dollars (discounted present value).

**REDACTED**

*Table 10. Summary of Expansion Plan Associated with Additional EGEAS Runs*

| | Case | | Case Description | NPV 30 years | NPV with Extension | Difference Compared to Base |
|---|---|---|---|---|---|---|
| **Future 1** | **P1F1** | (EDG5_45_P1F1) | Install SCR in 2011, WPL base assumptions | [redacted] | [redacted] | WPL BASE |
| | **P2F1** | (EDG5_12_P2F1) | Do not install SCR and retire Edgewater Unit 5 at the end of 2012, WPL base assumptions | [redacted] | [redacted] | [redacted] |
| | **P3F1** | (EDG5_BH_P3F1) | Install SCR in 2011 and Bag House and Scrubber in 2014, WPL base assumptions | [redacted] | [redacted] | [redacted] |
| **Future 2** | **P1F2** | (EDG5_45_P1F2G) | Install SCR in 2011, WPL Base Assumptions and Monetized CO2 Allowances | [redacted] | [redacted] | Future 2 BASE |
| | **P2F2** | (EDG5_12_P2F2G) | Do not install SCR and retire Edgewater Unit 5 at the end of 2012, WPL Base Assumptions and Monetized CO2 Allowances | [redacted] | [redacted] | [redacted] |
| | **P3F2** | (EDG5_BH_P3F2E) | Install SCR in 2011 and Bag House and Scrubber in 2014, WPL Base Assumptions and Monetized CO2 Allowances | [redacted] | [redacted] | [redacted] |
| **Future 3** | **P1F3** | (EDG5_45_P1F3C) | Install SCR in 2011, High Retention Value | [redacted] | [redacted] | Future 3 BASE |
| | **P1F2** | (EDG5_12_P2F3C) | Do not install SCR and retire Edgewater Unit 5 at the end of 2012, High Retention Value | [redacted] | [redacted] | [redacted] |
| | **P3F3** | (EDG5_BH_P3F3C) | Install SCR in 2011 and Bag House and Scrubber in 2014, High Retention Value | [redacted] | [redacted] | [redacted] |
| **Future 4** | **P1F4** | (EDG5_45_P1F4C) | Install SCR in 2011, Low Retention Value | [redacted] | [redacted] | Future 4 BASE |
| | **P2F4** | (EDG5_12_P2F4C) | Do not install SCR and retire Edgewater Unit 5 at the end of 2012, Low Retention Value | [redacted] | [redacted] | [redacted] |
| | **P3F4** | (EDG5_BH_P3F4C) | Install SCR in 2011 and Bag House and Scrubber in 2014, Low Retention Value | [redacted] | [redacted] | [redacted] |
| **Future 5** | **P1F5** | (EDG5_45_P1F5C) | Install SCR in 2011, Carbon Constrained Future | [redacted] | [redacted] | Future 5 BASE |
| | **P2F5** | (EDG5_12_P2F5C) | Do not install SCR and retire Edgewater Unit 5 at the end of 2012, Carbon Constrained Future | [redacted] | [redacted] | [redacted] |
| | **P3F5** | (EDG5_BH_P3F5C) | Install SCR in 2011 and Bag House and Scrubber in 2014, Carbon Constrained Future | [redacted] | [redacted] | [redacted] |

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Thank you for your consideration.

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MSG/kmc

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